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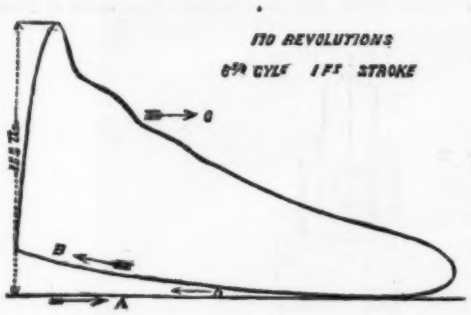
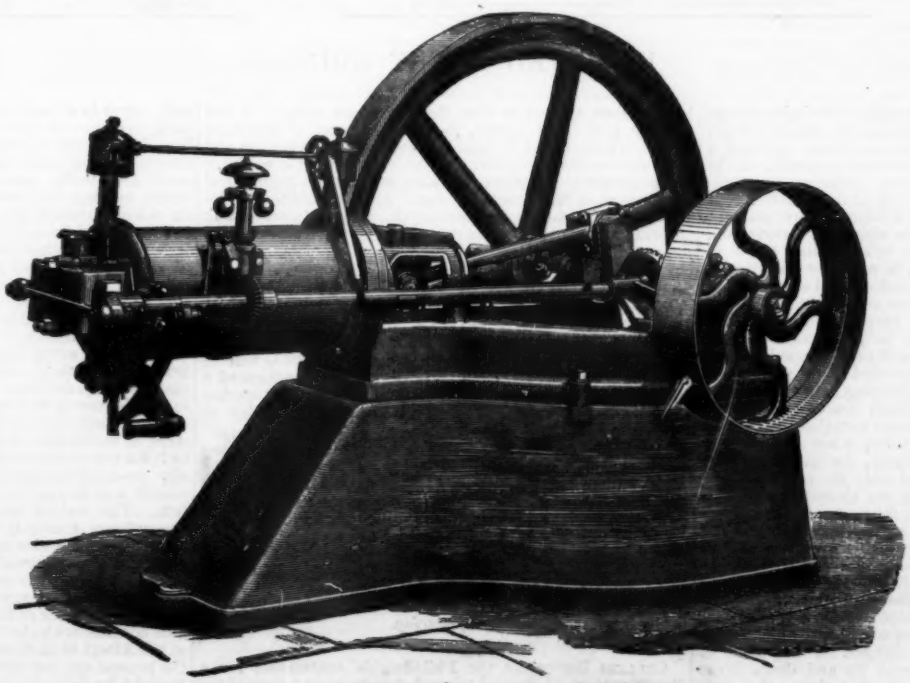
NEW GAS ENGINE.

THE accompanying illustration is that of a 3½ horse-power "Otto" silent gas engine, manufactured by Messrs. Crossley Brothers, of Manchester, England. The explosion and ignition are also so arranged that they take place at the commencement of the stroke, and by gradual expansion are effective throughout. To obtain a maximum pressure and throw the greatest amount of work from the smallest amount of material, the charge is first compressed before explosion in the cylinder of the engine. This is effected in the following manner: Supposing the engine is about to be started; the fly-wheel is first turned round by hand and a mixed charge of air and gas is thus drawn into the cylinder. The revolution of the engine is still continued by hand, which has the effect of compressing the charge of air and gas to a pressure of about 23 or 25 lbs. per square inch. At the maximum point of compression, when the compression stroke is just completed, the charge is ignited, and a pressure of about 150 lbs. per square inch is immediately developed. This at once produces a powerful working stroke, and maintains a gradually expanding and decreasing pressure down to 25 or 30 lbs. per square inch. The working stroke is thus single-acting and in alternate strokes. There is, however, sufficient power to develop up to 12 or 13 indicated horse-power in a cylinder of 9 inches diameter. The annexed diagram represents a cylinder of 6¾ inches diameter and 12 inches stroke, and shows first the charging stroke by the horizontal line, A, then the return compression stroke by the line B. The explosion and ignition cause the effective pressure to rise suddenly to the point C, and the gradual expanding pressure of the gas is shown in the hyperbolic curve, D, and the return discharging stroke is from D to E, getting rid of the exploded gases.



The cylinder overhangs, and is cast closed at one end and with a flange at the other, where it is bolted on to the framing and guide bars. The connecting rod, slipper-guide, crank and fly-wheel are arranged as in an ordinary engine, but the valve motion is driven by a rotating spindle and bevel gearing. This spindle runs along the side of the cylinder and terminates in a small crank, which in revolving moves a slide-valve horizontally backward and forward across the end of the cylinder. This slide-valve admits air and allows the ignition-jet at the proper time to explode the compound mixture of gas and air. A revolving cam upon the valve spindle strikes a lever, which moves on a fixed spindle, and which, on the lower end, lifts the gas-valve. The striking gear for this gas-valve is under direct control from the governor, which can, by the rise and fall of its arms, either cause the opening of the valve or throw the striking gear out of contact altogether. In this way the admission of gas need only take place once in half a dozen strokes when the engine is running light, or may take place every other stroke when the engine has its maximum duty to perform. This forms a most effective and simple governing arrangement. Upon the top of the cylinder is an oiling apparatus, which is brought into steady and continued action by the revolution of a small countershaft with dippers, which is driven from the rotary valve spindle.

The engine is mounted on a neat cast-iron under frame, so that it is complete without further foundation. The whole of the workmanship is very strong and all wearing parts are supplied in duplicate to accurate gauges. The rate of consumption of gas is economical in these engines; they are said to cost no more than one penny per hour for each indicated horse-power in the cylinders, which will make the cost a little more than one penny per hour for each effective horse-power on the brake, or in actual work.—*Iron.*



NEW GAS ENGINE.

ON A NEW METHOD OF BALANCING THE ENGINES USED IN WINDING FROM THE DEEP SHAFTS OF WESTPHALIA.

By W. FAIRLEY, Mining Engineer, and Certificated Colliery Manager.

THAT was a curious piece of experience when the writer, a few years back, under a peculiar state of affairs, was compelled to wind coal from a deep shaft in Westphalia, with only one cage, and with a large single-cylindered, high-pressured, first-motioned engine. The true circumstances were these: Depth of shaft, 116 lachters, equal to 132⅔ fathoms; engine-cylinder, 42 ins. diameter; stroke, 5 feet; 1st motion. A balance weight being hung in the pit from a smaller drum on the same axle as the large winding drum, this weight, for want of room, could only run about 55 lachters, or less than half the depth in the bottom part of the pit, as the greater portion of the shaft was taken up with various sets of pumps, timber, and brattice. The cage ran in wire-rope guides, and, as might be expected, oscillated most alarmingly when running. Of course the arrangement was only temporary, and fortunately did not last long, but it had its lessons; among others, one most decisively was that wire-rope guides are most unsuitable with an engine of only one cylinder, drawing an unbalanced load. In another case, under the same firm in that district, the wire-rope guides worked well, and the cages ran in them very steadily, the machinery being worked by a pair of engines.

Since his return to this country the writer has, as far as possible, kept himself posted up in the progress of mining engineering in that great coal field, and most recently had some correspondence with a practical mining engineer there, Herr Gehres, manager for the Westphalia Colliery Company, on the subject of balancing engines in winding, and as that gentleman has gone so thoroughly into the details of the subject he is now enabled to present to the readers of the *Mining Journal* the following particulars of what has been done in this respect by the Germans:

The attempts in a general way which have hitherto been made to balance the winding-ropes are pretty well known, and reference only need here be made to flat ropes and spiral drums, which have been tried on the largest scale. The flat ropes have, however, been found to have so many disadvantages, particularly in very deep shafts, that they have only been used in isolated cases. The spiral drum has been looked upon very favorably, and in this neighborhood for a time most of the new collieries have been fitted up with it; its day is now past, as is proved by its imperfections. It is not necessary to discuss this further here, but we will proceed to mention a new method of balancing, which in all probability has a greater future than anything that has yet been tried. At Hanover Colliery, by Wattenscheidt, the old winding arrangements have been altered by removing the hitherto used conical drum and replacing it with a single sheave of 7 meters (say 23 ft.) diameter attached to the main shaft of the engine. The periphery consists of timber, which is provided with a notch to receive the rope. A rope is passed over this sheave, A (see Figs. 1 and 2), each end of which after passing over the rope-pulleys is attached to the cages, B, C, Fig. 1. To the bottom of each cage a rope (called the balance rope) is attached of the same dimensions and consequently same weight as the winding-rope, so that two ropes are always hanging in the shaft, which act mutually as a counter balance. This winding arrangement works in the simplest manner, and with the least application of power, which in winding has certainly a great dead-weight and somewhat of friction, but only the net weight of the coal to lift.

At the above-mentioned colliery this answers well, and, indeed, with an old single-cylindered machine. It has not been found necessary to fix a sheave under the hanging-on at *d* (Fig. 1), for the balance rope, because the rope has worked well without it. The position of the machine in respect to the shaft was certainly favorable here, because both of the rope-pulleys were in a line over each other (see Figs. 1 and 2), which may probably not often be the case. The introduction of this system is rather more difficult when

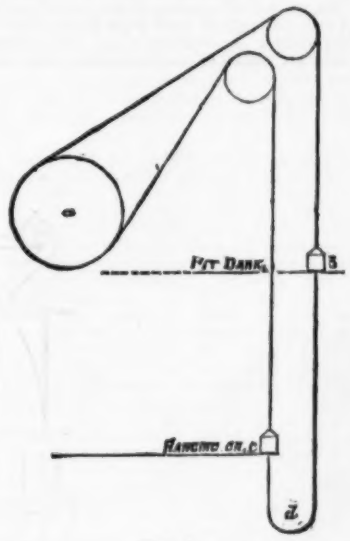


FIG. 1.

the relative position of the machine and shaft is different from that mentioned above, which is probably generally the case, particularly in newly laid out works, where the distance from the winding machine to the shaft is not great (as in Fig. 3; see next page), or in the alteration of old plant, where these unfavorable conditions are generally to be encountered.

The advantages of this arrangement catch the eye, and are indisputable, and it is wonderful that the plan has not been carried out long ago, although similar plans of balancing were known. In this, however, we have disadvantages to consider, and the principal is that only one rope is used. Every one with experience in these matters knows that the winding-rope is most injured at the lift where the rope touches the pulley. In ordinary arrangements this difficulty is overcome by cutting the rope and altering the length, so that another part of the rope comes in contact with the pulley. This, however, is impossible in this case, even by joining a piece of chain, as the rope must preserve its fixed length. Of course the rope could be spliced, but this with a thick rope of great strength and for a great depth would be difficult. The use of only this one rope is generally so much trouble that it will in the end become as dear as by one of the following arrangements with two ropes.

The whole contrivance is very simple. If we turn away from the sheave on the axle, and make the arrangement suit the existing machinery by using the two old drums instead of one sheave, the advantage will be that the old ropes can be used, and that there will be two ropes instead of one: for the balance rope an old worn out rope may be used. We will, therefore, look upon the existing drums as for round ropes—*i. e.*, spiral, conical, or cylindrical drums. We must look upon spiral drums as different from the others, as by their construction balancing is to some extent possible. As the conical drum is nearly uni-

versally in vogue in this district, it requires the most of our consideration to take advantage of it. It is necessary to decide whether by the continual change in the diameter of the drums the difference in length in the two ropes is not too great, which will give a greater velocity to the balance rope, and possibly endanger the shaft or cages. We will take into

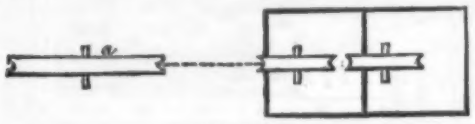


Fig. 2.

calculation two rope drums, the largest circumference being 15 and the smallest 12 meters, and having 25 coils of rope—*i. e.*, wound on and off. The complete run of the cage or journey will be divided into 26 parts, so that the first part is at the

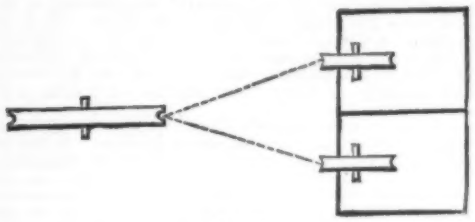


Fig. 3.

beginning of the journey, the second at the finish of the first stroke, or on and off winding of the first coil, part three the finish of the on and off winding of the second coil, etc. The length of rope or depth of shaft from bank-head to hanging-on is 337·5 meters. In columns *b* and *d* the lengths of the ropes as they are wound off and on at each round of the drum

Strokes or coils.	Descending rope.		Ascending rope.		Length of the balance rope on each side of the shaft above the hanging on.	Length of the balance rope under the hanging on on each side.
	Length from pit bank downwards.	Length of balance rope to hanging on.	Length from pit bank downwards.	Length of balance rope to hanging on.		
a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*
1	—	337·500	337·500	—	337·500	—
2	15·000	322·500	325·500	12·000	334·500	1·500
3	29·875	307·625	313·375	24·125	331·750	2·875
4	44·625	292·875	301·125	36·375	329·250	4·125
5	59·250	278·250	288·950	48·750	327·000	5·250
6	73·750	263·750	276·250	61·250	325·000	6·250
7	88·125	249·375	263·625	73·875	323·250	7·125
8	102·375	235·125	250·875	86·625	321·750	7·875
9	116·500	221·000	238·000	99·500	320·500	8·500
10	130·500	207·000	225·000	112·500	319·500	9·000
11	144·375	193·125	211·875	125·625	318·750	9·375
12	158·125	179·375	198·625	138·875	318·250	9·625
13	171·750	165·750	185·250	152·250	318·000	9·750
14	185·250	152·250	171·750	165·750	318·000	9·750
15	198·625	138·875	158·125	179·375	318·250	9·625
16	211·875	125·625	144·375	193·125	318·750	9·375
17	225·000	112·500	130·500	207·000	319·500	9·000
18	238·000	99·500	116·500	221·000	320·500	8·500
19	250·875	86·625	102·375	235·125	321·750	7·875
20	263·625	73·875	88·125	249·375	323·250	7·125
21	276·250	61·250	73·750	263·750	325·000	6·250
22	288·750	48·750	59·250	278·250	327·000	5·250
23	301·125	36·375	44·625	292·875	329·250	4·125
24	313·375	24·125	29·875	307·625	331·750	2·875
25	325·500	12·000	15·000	322·500	334·500	1·500
26	337·500	—	—	337·500	337·500	—

great depths are attained the conical drum has been established, and in the future introduction of this system of balancing, which is sure to take place, its inconvenience must be taken into consideration along with its cost. Finally, the writer may remark that one great advantage in the balance-rope system is that the cages are certain to run steadily, and, consequently, facilitate the use of wire-rope guides, which under favorable conditions are cheaper and more convenient than wood. If the English mining engineer thinks proper to introduce this plan, which from its practical application at Wattenscheidt seems recommendable, his ingenuity will undoubtedly discover the means of overcoming the difficulties attending its use, above referred to.—*Mining Journal.*

A CHAPTER ON COMPACTED BEAMS.

By Thomas Morris.

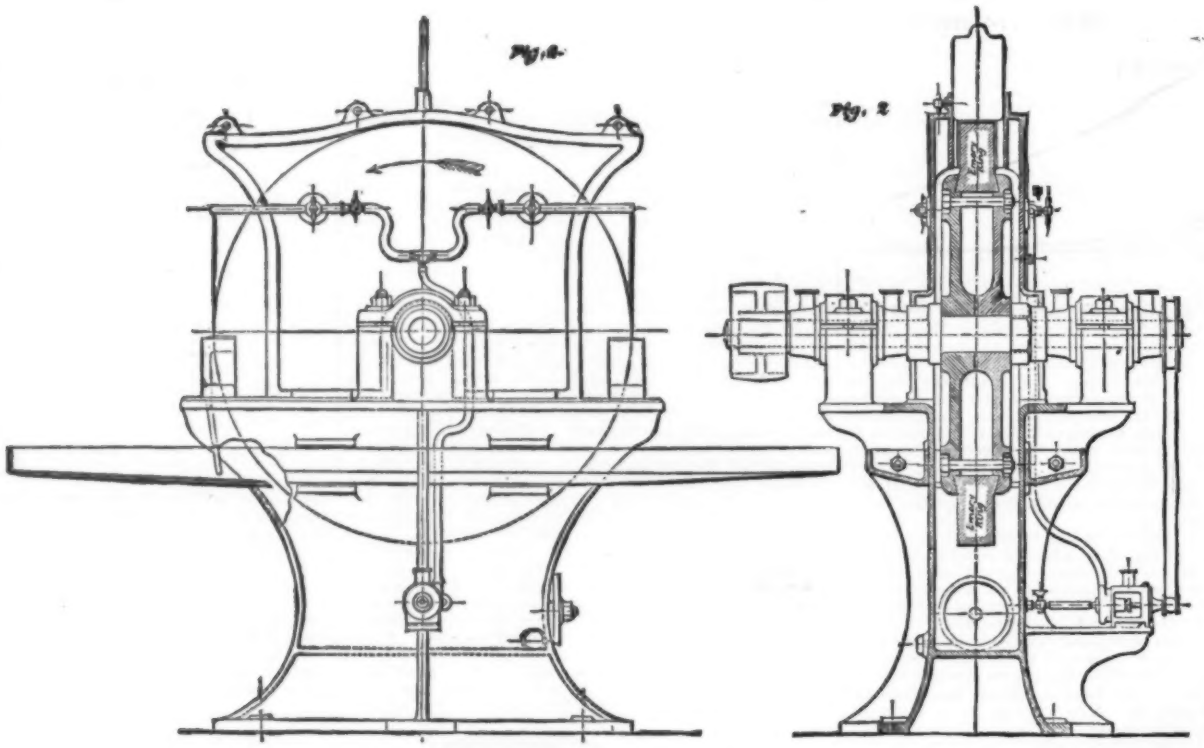
Works of magnitude in timber require larger beams than a single tree affords, and the means of combination becomes a necessary inquiry. The subject has given rise to many contrivances, but, so far from being exhausted, is in fact sufficiently open to excuse an *ab initio* glance.

In order to be at home in compacting beams, familiarity with the properties of materials and effect of mechanical appliances is requisite; but safety is so much more essential than exactitude, that it is customary to throw aside as great a proportion as five-sixths of the extreme power.

If we examine the natural construction of a tree, it is seen that the stem consists of the pith or central marrow, the wood, and the bark. The pith, having no office to perform when the tree has become mature, dies. It is surrounded by the medullary sheath, from which rays of compact tissue communicate with the bark. They are especially noticeable in oak, of which they constitute the characteristic figuration called *silver grain*. The wood encompasses the medullary sheath in concentric layers, one of which is added every year, and never changes its original size. Each annual edition comprises two distinct plates. The innermost is soft, porous, and vascular; the other consists of compact, fibrous, woody tissue. Secretions are gradually deposited in the vascular layers, and their liquid contents displaced. The deposits being more abundant in the older central portion, give to that part the perfected nature of heart wood; while the recent layers, with vegetable liquids in full activity, are known as sap wood, or alburnum, of inferior strength, durability, and value. As the fluids consolidate, and the vascular plates are condensed by seasoning, the breadth decreases, but the fibrous rings are less affected, and lengthwise there is no serious reduction.

Owing to this two-part formation, timber has a dual scale of strength, according as the fibrous and vascular plates are respectively brought into resistance. In any attempt either to elongate or to compress timber, the woody fiber is acted upon; but a dividing force, at right angles to the grain, tries the vascular plates, as does also such a strain as would draw a bolt, near the end of a scantling, out of the wood. Experiments show that good European fir, where all allowances for convenience and security have been made, is practically equal to a load of one thousand pounds on the square inch, whether in the way of extension or compression. The latter may be endwise or flatwise, but, in ultimate effects, tension stands highest, compression against the grain next, and, lastly, compression across it. But a transverse strain, tending to produce a sliding of the plates, must not exceed one hundred pounds per inch!

The natural force, or cohesion, by which particles of matter are kept together constitutes an important characteristic of all substances, and greatly influences their fitness for specific uses. Fir possesses this property in a very inferior degree to wrought iron. Taking the maximum of timber as one, the working ratio of iron may be reckoned at six, and it has the advantage of offering nearly the same resistance to strains in every direction. On this account rolled iron beams have their top and bottom flanges equal. But cast iron is so deficient in this homogeneity, and especially in tensile power, that the lowest flange of a beam has to be six and a half times as heavy as the upper; and while, as a strut, it would bear three times the load for fir, it is inferior to it for the duty of a tie. Looking, however, to iron generally, its complete subserviency to the carpenter's art has caused it to be recognized as a powerful and habitual auxilium. The weight being twelve times that of fir, and the strength six times, it follows that ironwork of the same ability will be twice the weight of woodwork. But notwithstanding this drawback, the metal now assumes a character in which it was quite unknown to the mediæval builders. The sparing manner in which it was employed by Wren in the dome of St. Paul's, even, would form a remarkable contrast with the free use given to it by General Scott at the Albert Hall, South Kensington. At the beginning of the present age bar iron was still a rarity, and the carpenter thought it a bold act to introduce a few slotted straps (excellent in their way), a king bolt, or other fortifying details, after the example of James Stuart (of Athenian memory),



IMPROVED EMERY GRINDER.

IMPROVED EMERY GRINDER.

We annex engravings of one of the emery grinders constructed by Thomson, Sterne & Co., of Glasgow, this grinder being fitted with one of Messrs. Handyside & Sterne's patent emery rings, as shown in Fig. 2. From this view it will be seen that the grinding material is disposed in the form of a ring having such a section that it is held firmly together between a couple of plates which are bolted together as shown.

The shaft on which the ring is mounted has very long bearings, the plummer blocks being cast in one with the water trough, which forms, as it were, the frame of the machine. A small centrifugal pump, arranged as shown in Fig. 2, raises the water from the trough and delivers it on to the wheel, the arrangement of the water pipes being clearly shown in our illustrations. The hood over the wheel carries a slide which can be adjusted as shown in Fig. 2, and the whole design of the tool is worked out with a care and attention to points of practical detail which well deserves commendation.—*Engineering.*

Collins Brothers, the Philadelphia contractors for a Brazilian railroad, desired to employ negroes on a part of the work; but an old law forbade the landing of negroes in Brazil, and a special permit has just been obtained.

in the roof of the Hospital Chapel at Greenwich—a very able work, repeated at the Grecian edifice at St. Pancras, Euston-road. It is not long since constructors thought it possible to strengthen beams by artificial internal arrangements of similar material. They opened the wood, cut pieces out, and filled the voids in ways mysterious; but their imaginings proved fruitless, and nature continued unsurpassed. Yet it may be fair to admit that the philosopher's stone to which so many experiments had been sacrificed, and at which a modern student would smile, at length appeared. Not, indeed, as wood of any kind, or in any form of application, but as iron, represented by the rolled flitch, preceded by various kinds of trussing.

It is constantly impressed upon visitors, by the curators of ancient buildings, as though to excite surprise, that intricate examples of woodwork are without nails or screws. This is perfectly true, for the time at which those now universal articles became general is comparatively recent. *Clout* nails were probably the earliest, and *clou* being the French for nail, it may be guessed whence they were derived. Wooden pins and treenails have, however, been quite superseded by iron substitutes, which owe to American skill a share of their present perfection, and constitute the subject of a very considerable British industry. In this class screws deserve especial notice, because (as the carpenter does not employ cements) of their mechanical utility in effecting that forcible contact of surfaces which adds the element of friction to their own power. A screw one-eighth of an inch diameter within the worm is equal in this way to 90 lbs., and as the power increases as the square of the diameter, a five-eighth solid core would represent a ton. The thread should be long and the head square, where much force is necessary; but in other respects the less resemblance there is to the ordinary bolt the better. The latter is, perhaps, the least efficient of modern contrivances of the sort, having no hold upon the fibers, and the timber is released from its grip by the slightest shrinkage. The one solitary recommendation of the bolt and nut is facility of application. Let me now proceed to connect the parts of a beam intended for exposure to a tensile strain. The beam is rectangular, and the dimension tenacity with the parts united. Here every part supplies an addition of power, and in an increasing ratio; since, as pointed out in a previous chapter, if one beam be laid upon a similar, the ability to sustain a load is not merely doubled, but quadrupled; and if a third beam be added, the power becomes ninefold.

But, in order to insure the full effect, all the parts must be connected so as to resemble, in the aggregate, a single tree. If numerous sheets of paper be fastened together at one edge, and then rolled into a cylindrical form, the leaves slide upon each other, and offer little resistance to the force applied. Such sliding has to be counteracted in beams, and laborious measures have sometimes been adopted for that end. Serrated joints were frequently used, with no small sacrifice of material and time. Keys, at moderate intervals, are efficacious, but, from what has been said on cohesion, it is apparent that their fibers should run at right angles to the grain of the beam. The surfaces of the layers should be kept in close longitudinal contact by screw-bolts cut with a thread for wood, in lieu of the common iron nut.

In a beam supported at the ends and loaded at the top an action is set up throughout the fibers. Those near the top are compressed and those at the bottom extended, while a neutral plane or axis exists between them whose length is unchanged. M. Du Hamel experimented with willow-bars half an inch square, and broke them with a central weight of 45 lbs.; but by cutting them one-third through from the top, and inserting a wedge, he raised the weight to 51 lbs. A bar 1½ by 1½ in. broke with 525 lbs., but a similar one was cut three-fourths through, and, a wedge being inserted, the load was applied until the fibers were well compressed; it was then removed, a thicker wedge put in, and the load was raised to 577 lbs. More recent investigators have pursued the inquiry, but the practical result is that fir beams of rectangular section have the neutral axis at the middle of the depth, and the strain upon the fibers is in proportion to their distance from that axis. But although such experiments are valuable as demonstrating an important theory, they afford little warrant for executive repetition; for, in the search after an accession of strength, amounting to some ten

COMPACTED BEAMS.

10 by 6, giving a sectional area of sixty inches, and an assumed power of 60,000 lbs., or nearly twenty-seven tons. The most obvious course would be to overlap the lengths, and fasten the broad faces together by means of 27 *one-ton* screws, as shown in Diagram A, where half the number are on one side and half on the other. If the ends were now pulled in opposite directions the joint would be as strong as the single parts; but the stress would not be along the center of the pieces, and that want of directness would generally be fatal. The method called "fishing" is, therefore, resorted to, and consists in abutting the ends of the pieces to be joined, and adding at each side a fish of half the scantling, so that the continuous fibers are just equal to those that are interrupted. But, as the fishes have to receive the entire strength of one part and convey it to the other, there must be twenty-seven screws on each side. A strong connection is thus made, but the appearance is clumsy, and, where neatness is an object, other plans are followed. The fishing joint is explained by Diagram B.

By the process called "tabling," or "indenting," the fibers may be caused to interlock to the extent of one-third of the entire section, and thus to leave only two-thirds to be supplied by additions.

This method, drawn in Diagram C, is as follows:

First, the indenting has to be proportioned to the 20,000 lbs. assigned to it, and as each square inch is equal to 100 lbs., it is clear that the strained surfaces must each measure 200 inches. The depth being ten, the length must be twenty. But each beam has been reduced to a third of its original section, and in this instance one-third is made up for on each face by a plate of iron. Had a plate or fish of wood been proposed, the section would have been 10 by 2, but one of iron 7 by ½ in. has the same effect, and is secured by 18 one-ton screws. I venture to speak of screws in this allusive way to their powers, because, if the principle here suggested became general, the manufacturers no doubt would be ready to adopt an indicative nomenclature. I am disposed to fear that two plates of half-inch iron, eight or ten feet long and seven inches wide, attached by 36 large screws, may seem enormous, but submit that they are consistent and proportionate to the cohesive force of fir; so that with a code of the sort before him, the carpenter can work with facility and confidence. He will at the same time perceive whether expense can be saved by an abatement of the full strength in any part, for it is only on the assumption that very great abatements are practicable that the oblique and fanciful jointings of a former day, such as exhibit the curious elaborations of Batty Langley, can be supposed to have done duty for a moment. In recent examples, beams of great power are connected by a few almost worthless bolts; and so, according to circumstances, the rules here indicated are fairly open to modification. But the neatest and most effectual mode of compacting long beams would probably be by layers or laminations screwed together, with intermediate headings. They might thus be of any extent, and without perceptible joints, or additions of any kind.

The composition of beams for bearing purposes is easier and more satisfactory than in the class just considered. There the highest success was to make junctions of equal per cent., as much ironwork and labor may soon be expended as would far exceed the saving in wood.

By the introduction of large screws, as a structural element, into carpentry, it would be possible to follow very closely in timber the principle on which material in iron beams is massed at the greatest distance above and below the neutral plane. Take, for example, a beam 12 by 12, whose neutral axis would be at the middle of the depth. The center of gravity of the upper half would be three inches above the neutral line, and that of the lower half three inches below it. The cross area of $72 \times 3 = 216$, which is the effective power of the half, or 432 for the whole. But if the beam were divided into three planks 12×4, and built in the form of the letter I, there would be $24 \times 3 + 48 \times 8 = 456$ for each half, or a total of 912. The same quantity of timber, therefore, disposed in this way, would be fully twice as powerful as the solid timber; and the sectional figure would be convenient for application, as a support to other pieces, in a combined work of carpentry.

Were a beam of this formation required of a greater length than the material at hand, pieces to form the top might be closely abutted, those for the web halved vertically, and those for the lower flange flatwise.—*Building News.*

[NATURE.]

MISCELLANEOUS NOTES.

Analogy Between Chemistry and Algebra.—The first conception of the theory belongs to Frankland, who first announced it in his paper on "Organo-metallic Bodies," read before the Royal Society on June 17, 1853. After referring to the habits of combination of nitrogen, phosphorus, antimony, and arsenic, he says: "It is sufficiently evident, from the examples just given, that such a tendency or law prevails, and that, no matter what the character of the uniting atoms may be, *the combining power of the attracting element*, if I may be allowed the term, *is always satisfied by the same number of these atoms.*" He then proceeds to illustrate this law by the organo-compounds of arsenic, zinc, antimony, tin, and mercury.

Corsican Blackbirds.—Among the exports of Corsica it is said that there are annually between 350,000 and 400,000 blackbirds (*merles*) sent to the Continent. They visit Corsica in vast numbers each winter to feed on the berries of the myrtle and arbutus, with which the mountains are covered. In the month of December they become very fat, and the flavor and perfume given to their flesh by their food cause them to be much esteemed by the *gourmets* of Paris. A *pate de foie de merle* is a great delicacy.

Education of Insects.—The Société Centrale d'Apiculture et d'Insectologie has had constructed a pavilion in the Champ de Mars for the purpose of exhibiting in 1878, in the most complete manner, everything relating to the education of useful insects, especially bees, and the means of preservation of all kinds against noxious insects.

Live Savages.—Quite recently a band of Nubians were in London; a small band of Esquimaux are at present encamped in Paris, and now we hear that shortly Europe will have an opportunity of viewing a group of Aborigines from America. A number of Tierra del Fuegans are to be brought to Brussels, where they will be installed in the Zoological Gardens. The enterprising authorities of the Paris Zoological Gardens contemplate, moreover, importing some specimens of North American Indians, their plan evidently being to keep up a kind of anthropological review of the various civilized and semi-civilized peoples of the globe.

Electric War Lights.—The German War Department has recently carried out some experiments on a large scale with the electric light at Metz, in order to test its practicability for military purposes. One of the largest known electric lanterns was used for the trials, and it was found possible to distinguish small detachments out of rifle-shot with sufficient accuracy to direct on them artillery fire.

Shortsightedness.—The alarming rapidity with which shortsightedness is increasing among German students formed the subject of a recent debate in the Prussian Parliament. From extended observations made in the gymnasia, it appears that the number of the shortsighted increased from twenty-three per cent. in the first year to seventy-five per cent. in the ninth or last year. The too frequent custom in Germany of forcing lads to study during the evenings with insufficient light, in ill-ventilated rooms, is undoubtedly a main cause of this widespread evil.

Radiometer Experiments—While, of course, the thermo-electric pile is the most useful measuring apparatus in investigations on radiant heat, it is possible, M. Violle suggests (*Journal de Physique*), to repeat easily all fundamental experiments with the radiometer; by moving it along the spectrum one may readily show (even with the Drummond light) the distribution of the heat in the luminous part and in the infra-red region. The action of colored glasses, the absorption of heat by water, in layers of different thickness, and all similar phenomena, can be shown without any difficulty. The beam of light employed falls directly, or after passage through the absorbent substance, on the radiometer, the image of which is, by means of a lens, thrown on a screen. The experiment is very distinct and pretty; it may be rendered more precise by adopting an arrangement for counting the number of turns of the radiometer. M. Violle says he has had constructed by M. Alvergniat a small radiometer for the purpose; it is placed on a Duboscq projection apparatus, and the turns can be easily counted on the screen.

Ratio of Air Heats.—In order to determine the ratio of the specific heats of air at constant pressure and constant volume (a value so important for the doctrine of heat), M. Kayser has recently made fresh experiments on the velocity of sound in tubes. He adopted Kundt's method; in tubes of different diameter, air waves were produced by means of a transversely vibrating rod, and the length of these was measured by the dust figures remaining on the tube. Five tubes of different width were used, and three different steel rods. The results of the inquiry are these: (1) The velocity of sound in tubes depends on their diameter and on the pitch of the tones, and the retardation of the sound is inversely proportional to the diameter of the tubes and the square root of the number of vibrations. (2) The velocity of sound in unconfined space is accordingly at any rate greater than in tubes; these experiments showed it to be greater than 331·646 m. (3) The velocity of sound in free space can be calculated from that in tubes when two tubes of different width are used; from these experiments the value obtained for it was 332·5 m. (4) From this the ratio of the specific heats of air at constant volume and constant pressure is inferred to be — 1·4106.

Telephone Experiments.—Three experiments, made with a view to find how weak induced currents in the telephone would still suffice to give distinct perceptions by ear, have lately been described to the Vienna Academy by Prof. Sacher, of Salzberg: 1. The closed circuit of the telephone was, for a length of 20 meters, placed parallel with the insulated wire (cloth and wax) of an ordinary telegraph apparatus. The (Morse) signals were given first by means of six, then three Smee elements. The induced currents gave a distinctly audible effect in the telephone, so that the messages could be understood. 2. The insulated wire was laid bare at two points 20 meters apart, and the ends of a telephone wire 120 meters long, and equally thick, were connected to it at those points. Only a small portion of the current could have passed through the thin wire in the telephone. Yet the tapping was heard with sufficient clearness to enable one to understand the message. (It is an advantage to use a telephone at each ear.) 3. A telephone wire about 40 meters long was connected with the inner thick wire of an ordinary induction coil, and a second telephone line, about 120 m. long, with the outer thin wire. To Prof. Sacher's surprise it was found possible to communicate through the first to the second telephone, and also (somewhat better, it seemed) in the opposite direction; and this nearly as well as with direct connection. The words were perceived more distinctly when two induction coils were inserted in the same way. The experiments did not succeed with a Ruhmkorff.

How to Improve Alloys.—Many alloys of tin and other soft metals hardened by addition of antimony, copper, etc., do not give a clear tone on being struck, but a lead-like, dull one. It has been found by M. Lilliman (*Pol. Notizblatt*) that the power of sounding clearly may be imparted to them by immersing them for a half to one minute in a paraffine or oil bath, heated to a temperature 5° to 5·5° below the boiling point, then taking out and allowing to cool. This does not produce any diminution of density, but a considerable increase of the hardness and rigidity.

The Many-eared Telephone.—Professor John McKendrick, writing from the Physiological Laboratory, Glasgow University, to *Nature*, says that 'in endeavoring to utilize one telephone by making several friends listen at once, I have found that by fixing the metal disk to a thin membrane over a small cavity, filled with air, like Koenig's capsule, and having a number of flexible tubes connected with it, an ear placed at the end of each tube will hear distinctly."

A NEW KIND OF LIQUOR.—Dr. Mierdue, a French colonial surgeon, announces the discovery of a new beverage, which has already won popularity in Marseilles. The liquor is distilled from the leaves of the eucalyptus tree; it is said to be pleasant to the taste and not injurious to health, while possessing some valuable medicinal properties. The expectation is that it will take the place of absinthe as a stimulant; it is called eucalypsinthe. If half the tales told about the results of drinking absinthe be true, it is quite time that a substitute should be found for the extract of wormwood.

IMPROVED RADIAL AXLE-BOXES.

By H. W. Widmark.

These axle-boxes have been constructed at the Avonside Engine Works, Bristol, Eng., and several of them have been successfully in use in the United Kingdom and other countries for more than two years. The following is a description of this design, which is shown in full size in the accompanying diagrams, Figs. 1 to 4:

Each pair of guides, G G—always cast in one piece, and fixed to the main frames of the engine, as in Figs. 1 to 4—is distinct from the other, and is bored to a cylindrical surface, the axis of which is in the same line as the spring pillar. An intermediate guide or box, I I, Figs. 1, 2 and 4, the outer surface of which is turned so as to fit easily in the outer guide, can have a turning motion round its axis, and also an up-and-down motion, as may be required by the elasticity of the springs or the roughness of the road. The sides of the inclined passage through this piece are planed, and serve as a guide for the axle-box proper to work in. Both the outer and the inner guides have their lower forks connected by horn stays, H H, Figs. 2 and 4, to prevent springing.

The axle-box, B, has planed parallel sides, and is free to slide in a direction which is rectilinear and horizontal, but inclined to the axle of the wheels. The box at the opposite end of the axle is inclined in the opposite direction, as shown in Fig. 1; so that, when the wheels and axle deviate toward one side in consequence of the curvature of the road, the axle is simultaneously set in an oblique position to the engine frame, but radial to the road, one end being advanced in relation to the frame, while the other is drawn back by the inclined form of the axle-boxes and the intermediate guides.

Moreover, as the sides of the axle-boxes are parallel planes, and as there are no flanges, the axle-boxes are free to turn round a horizontal axis which is at right angles to these side planes. Thus one axle-box may rise and the other fall

LOCOMOTIVE ECONOMIES.

Mr. J. E. Wootten, General Manager of the Philadelphia and Reading Railroad, confirms, in his annual report to the company, the practical advantages of sundry alleged improvements in railroad operation that have been made the subjects of lively discussion and much diversity of opinion within the past two years. One of these is the working of locomotives continuously by a change of engineers at the end of each trip, which, Mr. Wootten says, has been attended with marked advantage as respects the relative cost of repairs, regularity of running, and the movement of an increased tonnage with a smaller number of engines. Another is the advantage of an established standard of locomotive construction, which has been demonstrated by the virtual renewal of a ten-wheeled engine, after sixteen years of coal-train service, at a cost less than one-third of that of a new engine, by merely renewing the boiler. The discontinuance of the practice of wiping and cleaning the exterior of locomotives, after a period of fifteen months, has resulted in no increase of repairs or injury to the working parts, although the engines have never been worked harder or more continuously than during the past year. The saving from this source is estimated at not less than $60,000 for the year. The utilization of coal dirt from the collieries for heating machine and car shops and running stationary boilers has also proved very successful, so much so that several locomotives are being fitted up for using waste coal for fuel.

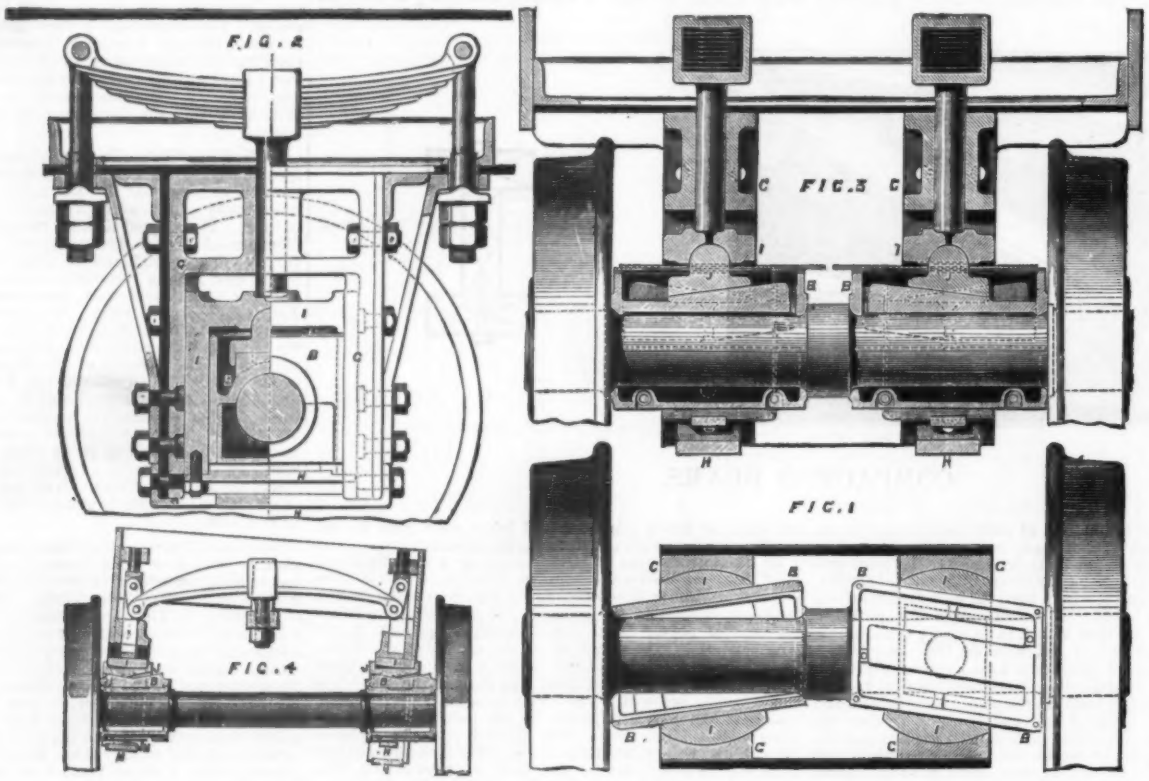
MINING NOTES.

When the Griffith brothers, the pioneer prospecters of the Georgetown district, in 1860, reached the site of the present town of Georgetown, or rather when they approached it, they must have thought that it was impossible to go any further from the way in which the mountains here arise like gigantic walls on all sides but one (the way they came) to a height of two thousand feet and more, almost perpendicularly. The was lately shipped to Professor Hill, running 2 8-10 ounces in gold and 10 ounces in silver to the ton. It is the intention to work right along, and as the depth attained by the main tunnel is considerable, this mine will before long probably produce a quantity of rich ore. Right among all the silver mines of this district it seems strange, yet there seems to be a belt of gold-bearing lodes on the north side of this mountain running into Griffith Mountain. In that direction some more gold-bearing lodes have been struck, which are not being worked much, partly for want of milling facilities. A stamp-mill in this town would not be out of place. Not only would the above mines furnish ore, but a supply might also come from Empire, some of the mines of which are doing very well.

The Knickerbocker twenty stamp-mill in Empire has lately been refitted and leased, working at present about three cords per day. The owners of the Pioneer lode have near their mine just finished a sixteen-stamp mill. Though there are at present no large number of men employed in Empire, it is expected that when spring opens it will be more lively. It is one of the most beautifully situated mining camps.

There is some talk now of an Eastern company intending to tunnel Democrat Mountain from Silver Gulch, which separates Republican from Democrat Mountain. The last being, as far as discovered from the top, honeycombed by mineral veins, they are apt to strike some valuable lodes by this enterprise.

At Silver Plume, which lies two miles from Georgetown, and which settlement has already nearly two thousand inhabitants, are situated the Silver Plume Sampling and Concentrating Works, in charge of Mr. John Sampson, a millman of large experience. The dimensions of the mill are about 100x45. It is built against the slope of the mountain, the only proper way to build works of the kind, and has a large supply of water from one of the forks of Clear creek. The capacity is about ten tons in three hours. A Blake crusher and Cornish rollers are employed, and further the wet concentration process of revolving screens and corresponding



IMPROVED RADIAL RAILWAY AXLE-BOX.

'n the guides, as required by the state of the road. This very necessary motion is prevented when the sides of the boxes form parts of circles fitting to corresponding curvilinear surfaces on the guides. Such boxes move freely only when they both stand at the same height in the guides, but would be in danger of jamming and fixing the axle if the oscillation of the engine or the irregularity of the road made one box rise more than the other.

In Fig. 4 is shown a frame with its guides in such an inclined relation to the wheels, axles, and radial axle-boxes. In the writer's design each axle-box system becomes a universal joint; for there is a vertical turning of the inside guide in the outer guide, a horizontal turning of the axle-box in the inner guide, and also of course the turning of the axle-box round the axle; thus there is no possibility of the axle becoming jammed in the guides.

As in this design the axle-box travels in a direction which is rectilinear, it is easy to arrange inclined planes on the top of the box, and corresponding inclined planes on a sliding piece, J, Fig. 4, which is held by the inner guide, and takes the thrust of the spring. By this means an elasticity is given to the axle, or a tendency to come back to a central position when not constrained by the curvature of the line.

On a straight line the axle is locked by the inclined planes just referred to, so that it becomes parallel with the other axles, whereby friction is prevented between the wheels and rails; in this way the engine is also steadied, the swinging action of the cylinders being prevented. One system of six inclined planes is shown in Figs. 1 and 4, and another system with only three planes in Figs. 1 and 3. In the first case the inclined planes are entirely above the box, Fig. 4, and are lubricated by separate oil pipes and grooves; in the latter case the inclines are placed over the box, Fig. 3, but at a lower level, so as to be surrounded by the upper flanges of the box, and are always immersed in a bath of oil, which is covered in and guarded from dust by fixed and sliding covers.—*Engineer.*

lode which at present still bears their name now belongs to the Wilson & Cass Company, of New York, who worked the property until 1870, since which time it has generally lain idle, but is worked now on lease by Mr. B. C. Catran. Though it is a large vein, the grade of ore taken out at that time did not pay for the work, but with the present facilities in the vicinity it is thought that it will pay a profit to the industrious miners engaged on it. The ore is a galena, carrying silver, copper and lead, with some gold. The main shaft is 200 feet deep; at sixty-five feet is a drift east 125 feet long and at 125 feet is a level east of sixty feet. In both of these levels considerable stoping has been done. At the bottom of the shaft a level has been started, but, as a good deal of water is coming in there, it will probably be necessary to put up an engine at the mine to do the pumping, before any work can be done—which engine can at the same time perform the hoisting. An adit is run about midway down the shaft through which some water is discharged, and which at the same time gives ventilation. An ore railroad 1,100 feet long enables the miners to carry their ore down to the road to be loaded on teams. The mountain is very steep, and the car going down loaded draws the empty one up.

The wire rope in use runs in the form of an eight, over two wheels, the one under the other, while a little wheel on its edge is placed between the two wires to keep them from coming in contact with one another. By this means a perfect control is had over the descending weight, which was not possible before, when only one wheel was used, as then even that wheel could be entirely stopped from running around by the brake without stopping the car. Mr. Catran is said to be the inventor of this useful improvement.

The Pulaski Tunnel, owned by an Ohio company, is steadily worked. The main Tunnel is over 1,100 feet deep in the north side of Lavenworth Mountain, without yet cutting the vein, but by present indications it will do so before long. Tunnels No. 1 and No. 2, respectively seventy and two hundred feet long, cut the vein, the pitch of which is about 45°. In No. 1 is a shaft twenty feet deep, out of which some ore jigs is applied to the ores. A forty horse-power engine gives the motive power.

The Burleigh Tunnel has now attained a depth of 2,300 feet, and is ventilated in a very ingenious way by water-power, a thirteen-inch wheel driving a Burleigh air-compressor. The work is now under charge of Mr. Theodore Schwartz, who takes care of the interests of the company during the absence East of Col. Phillips, the superintendent. Of the number of lodes cut by this tunnel, there are at present being worked, under lease, No. 1, the New Era, No. 9, the Ryder, and No. 13, the Phillips. On No. 1 is a drift running 300 feet west and 200 east; on the west drift is a shaft forty feet deep, from which they are drifting west now; considerable stoping has also been done on this vein. On No. 9 is a west drift of seventy and an east drift of forty feet, while on No. 13 a small amount of drifting is done. At this place in the tunnel it looks as if a tremendous wide vein is cut there, the crevice matter extending over a length of about ninety feet. The probability is that a number of lodes have here come together. At the Terrible Mine all the damage done by the fire a few weeks ago, of which very exaggerated reports found their way into the newspapers, has been repaired. This immense property has been constantly developed—about two hundred men being employed, of whom about one hundred are working on lease. The mill near the mine has lately undergone some repairs and has been covered with sheet iron.

The Dunderberg, a little east of the Terrible Mine, and supposed to be on the same lode, is worked on lease by parties who are shipping considerable rich ore down the mountain by means of jack trains. It is a very pretty sight, to a person who has never seen one of these trains come down a steep trail, to see a long string of these sure-footed animals with the bags of ore on their backs descend the mountain. These trains are very useful to the miners, whose cabins and mines lie far away from any roads, and who, by these means, can get their supplies brought up to them and ship their ores in return. Of course it only pays to ship high grade ore this way.—*Mining Record.*

NEW HAND-POWER ROCK DRILL.

THE hand-power drill we illustrate is the invention of Messrs. T. B. Jordan & Son, of Queen Victoria Street, London. It has important claims to the attention of mine and quarry owners, as the rate of boring is not only some four times as speedy as that of hand work, and this effected by a staff of workmen much fewer in number, but its first cost and the working expenses attending its application are less than other machinery in use for the same purpose. The broad results with this drill are these :—It will drill a 1¼ inch hole in granite about 1½ to 2 inches per minute. The average rate with hand labor is about 15 to 18 inches an hour with two men ; the machine with two men, or with a third to relieve in constant work, will thus drill, say, 80 to 90 inches an hour. In soft stone, such as Portland or sandstone, the rate with two men at the machine increases to about 6 to 9 inches per minute. The machine is arranged in several different classes of stands or frames, to suit distinctive purposes. We show these in our illustrations, Figs. 1, 2 and 3.

Fig. 1 shows the handiest and most portable arrangement for open quarry work. The frame is a triangular, A, arrangement, with the drill and hand-weel shaft fixed at the top. The frame is adjustable into its position by four hand set screws, one at each corner, and the frame and drill are kept steady by two heavy saddle weights placed over the bottom bars of the frame. These are shown in Fig. 3. When done with in any position, the machine in Fig. 1 can be lifted by the handles to the frame and wheeled away like a wheelbarrow. With this machine holes can be drilled at any required angle from vertical to horizontal. Fig. 2 is an arrangement for boring holes into a heading. In this the drill swivels into all inclinations between two upright frames. These frames have adjustable feet for height of tunnel or heading, and at the top two set screws, which can be screwed home into the roof, and thus jam the frame into position securely, so as to bring the drill into operation against the face of the rock. The angle of the drill is fixed by a swivel-rod from a cross stay in the lower part of the frame, and the swivel-rod is fixed by a set screw. The width of this machine is only 2 feet over the handles, and it can be wheeled up to and away from its work on the hand-wheels. Fig. 3 may be used most conveniently for sinking or for general purposes ; it is intended for vertical and slightly inclined holes only ; it is readily fixed to its work, being very portable. Although this last form of machine will prove a most useful one for sinking or quarrying, the inventors have lately made another arrangement (Fig. 4), which is specially convenient for sinking shafts, to render the machines perfectly independent of the irregularities of the bottom of the shaft. Two drills and a stand for the men are carried in a wrought-iron frame, which is slung in the center by a chain from the top of the shaft. The transverse bars of this frame, top and bottom, are formed by two pairs of elbow-levers, which can be closed or opened at the center by a right and left handed screw, turned by a hand-wheel. At the ends of the two elbow-levers are two timber claws, which, by the thrust of the elbow-levers, jam themselves hard against the sides of the shaft. This securely fixes the frame and drills into the shaft, and the drills, being adjusted as to position and angle, can be at once set to work without any further adjustment, however irregular the floor may be. When it is desired to blast, the elbow-joints and clamps are released, and the whole apparatus is swung up out of harm's way. After the blasting operation, it may again be lowered and clamped into place, and drilling may be recommenced. The frame may be also revolved round its axis, so as to bring the drills over all parts of the shaft bottom. This appears to be a very convenient and compact arrangement.

Fig. 5 shows a section of the machine and its mode of action. C is the air-compressing cylinder in which the drill-piston, L, is made to work up and down. This is effected by the rotation of the large fly-wheels by the attendant unskilled laborers. The cranks, K, are keyed on to or forged with the fly-wheel shaft, and therefore rotate with it. As they rotate, the cams come under the cast-iron boss, H, raising it, and allowing it to fall twice in every revolution of the hand-wheels. Through the boss, H, passes a combined steel and gun-metal sleeve, L and D, in which is the drill holder, G. G is a long bar, hexagonal at the lower part, to revolve with its steel sleeve and piston, L, and screwed for a considerable distance at the upper end, and running in a corresponding thread of the upper gun-metal sleeve, D. This latter gun-metal sleeve has a series of bearing rings turned on it, which thus transfer the weight of the bar to the block, H, at the same time allowing the sleeve to rotate in the boss. The lower sleeve and drill must rotate with the boss. When the cam comes under the boss to lift it, at the same time it rotates the boss and the drill with it through an angle of about 30°. This causes the drill to strike successively in different positions, and thus to form a round hole. The friction of the gun-metal sleeve in the boss, H, would naturally cause the sleeve to rotate with the boss and drill bar ; the miter wheel, E, without which the gun-metal sleeve cannot rotate, is keyed and geared into another miter wheel, E, on the framing; this latter miter wheel spindle has a hand-wheel, A, keyed on it, and a jam thumb-screw, B, on the end of it. If this jam-screw be tightened, the miter wheel cannot revolve ; the sleeve, D, is thus held fast, and the rotation of the drill causes it to feed forward by the thread tapped into the sleeve. This is a simple and ingenious feed-motion, and is capable of most delicate adjustment by the thumb-screw, B ; as it is also always rotated and fed by friction, it can never injure or break the drill. F and F are two cup leathers, making the cylinder air-tight. The holes in the bottom of the cylinder communicating with the atmosphere are seen in the drawing, and two top channels to press the upper leather home. The air in the cylinder is compressed to about 60 lbs. per square inch, and expands about four times in the descent of the piston, which makes a total average descending pressure upon the drill of about 130 to 140 lbs., through a distance of 4 inches. This is much in excess of anything that can be produced by a jumper. We observe that the well known firm of John Taylor & Sons have been using this drill for their granite quarries, and that it has there proved most successful and satisfactory. It is boring holes in the granite 1¼ inch in diameter at the rate of 1 inch per minute ; two men, with a third to relieve them from time to time, experience no difficulty in continuously keeping up this rate all day.—*Iron.*

HEAVY MINING MACHINERY.

WE have had the pleasure of examining the immense new pumping machinery manufactured by Prescott, Scott & Co., of the Union Iron Works in this city, for the Yellow Jacket Mine, on the Comstock. This is the heaviest machinery of the kind ever made on this coast, and probably in the United States. An idea of its magnitude will be best conveyed in the statement that the engines, pumps, boilers, etc., weigh in the aggregate upward of 1,200 tons, and these large iron works, employing about 500 men, have been nearly five months engaged on the job, the expense being upward of $300,000. The engine, air pump, etc., was all set up in the shops this week, and numbers of persons availed themselves of the opportunity of examining its massive proportions. It is now being taken apart and shipped to its destination. A special car had to be constructed to take portions of the machinery which were too heavy for the ordinary flat cars.

The machinery consists of a horizontal compound condensing engine, the cylinders being set side by side. The engine bed consists of a box frame of cast iron to take the outside flanges of the cylinders, main guides and fly wheel shaft pillow blocks, which are all securely bolted in their respective places. This frame is 64 feet long, 18 feet wide under the cylinders, and 34 inches high, each side being in three pieces bolted together, one side being connected to the other by three cross braces. In addition there is another box frame to which the inside flanges of the cylinders are bolted. This frame is 34 inches high and 20 feet long.

The initial cylinder is 31 inches in diameter, and weighs 12 tons; th expansion cylinder is 62 inches in diameter and weighs 30 tons. As economy in the consumption of fuel has been kept prominently in view in the construction of these engines, every possible precaution has been taken to prevent loss by condensation. To this end the cylinders and cylinder heads are steam jacketed; that is, the cylinder is really made in two parts, an outside shell and a "liner," and between these two parts is left a space which is kept filled with steam. The liner is the inner shell in which the piston slides, and has the outer shell shrunk over it, flanges on which it rests being placed between the two shells, so that the steam may completely envelop the liner.

The bore of the initial cylinder is 31 inches, the liner is 1¾ inch thick, and the space between the liner and inner side of the outer shell is three quarter inch all around, thus forming a steam jacket, steam being admitted to the space referred to so as to keep the cylinder at a proper heat to prevent condensation. The bore of the liner of the large cylinder is 62 inches and the thickness of the liner 2 inches, the inside diameter of the outer cylinder being 67¼ inches.

FIG. 1.

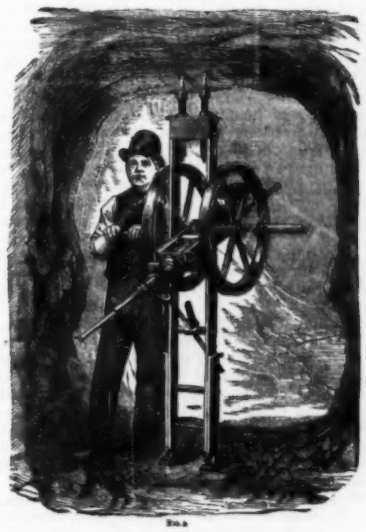


FIG. 2.

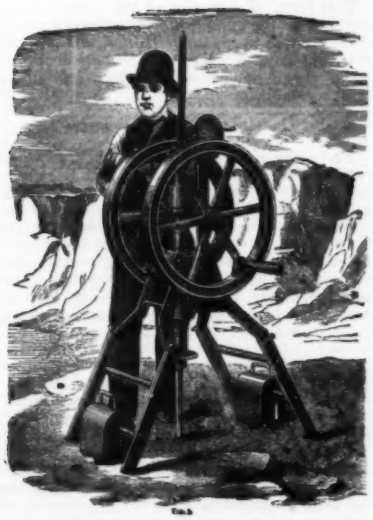


FIG. 3.

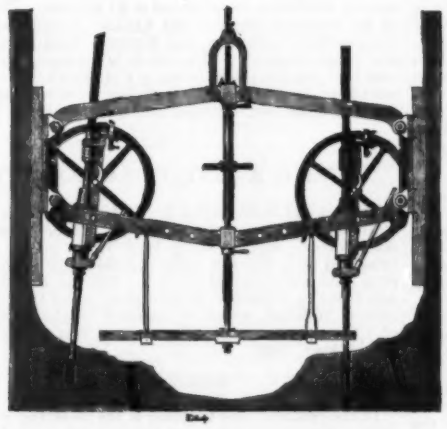


FIG. 4.

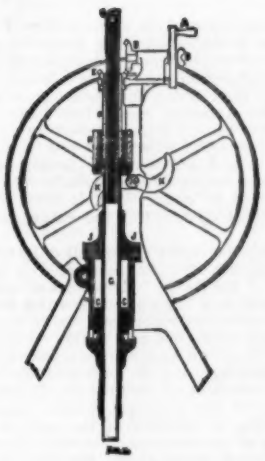


FIG. 5.

IMPROVEMENTS IN HAND-POWER ROCK DRILLS.

It was no small job to make steam jackets on such large cylinders. To accomplish it, after the outer shells of the cylinders were bored true, they were set on end, and fires lighted inside of them so as to expand them by heat. Then the liners were lifted by the cranes and lowered into their places in the shells, which shrunk tight around the liners on cooling, leaving a space of three-quarter inch all around for steam.

The outsides of the cylinders and the cylinder heads are covered with five inches of asbestos; and the steam pipes, and all exposed steam surfaces, are covered with the same non-conducting material, of the best quality, to prevent condensation and consequent loss.

The piston rod of the initial cylinder is 6 inches in diameter, and that of the expansion cylinder 10 inches. The cylinder heads are fitted with relief valves, as is usual in engines of this size. The relief valves have their seats at the inner face of the cylinder head, thereby saving the clearance of the old style relief valve. The clearance of the cylinder steam passages and valves is reduced to the smallest possible space consistent with safety.

The engine has a 12-foot stroke, both pistons being connected to one cross-head, on which they work simultaneously. This cross-head is an immense piece of metal, which weighed in the rough over 22,000 pounds. It is probably the largest piece of wrought iron ever forged in this city, and has been beautifully finished since forging, the sides and edges having all been rounded off. It is 20 feet long, 9 inches thick one way and 3 feet thick the other. The main guides for the cross-head form a portion of the engine frame.

A direct connection is made between the cross-head and the main pump bob by a single open pitman rod. This had to be made in a peculiar manner for the sake of compactness, to allow the fly wheel shaft to rest on the pillow blocks on the frame in a direct line between the cross-head and the pump bob. Therefore a solid iron rod was inadmissible. This main connecting rod or pitman is 40 feet long between centers, and 49½ feet long over all. It is an open strap rod, the sides being formed of wrought iron plates 3 inches thick by 18 inches wide, the thickness being increased to four inches at each end. This is braced by a plate on each side 1¼ by 15 inches, securely connected by rivets and angle irons, forming a T iron. The two sides are bolted together at the ends and at intervals by 15 three inch bolts, leaving an open space in the middle of the rod through which the crank shaft passes. The journal of the pin of the pump bob is 12 inches in diameter and 16 inches long.

There is also a connection from each end of the cross-head to two 30 feet balance wheels by 24 feet connecting rods, working on pins of 6 feet cranks, these cranks forming part of the balance wheels. The balance wheels are placed one on each end of an 18 inch wrought iron shaft working on journals on top of the engine frame, the position of this shaft being between the cylinders and the pump bob, passing between the open part of the main pitman rod as before stated. The journals of the fly wheel shaft are 18 inches in diameter by 24 inches long, the shaft being 18¼ inches in diameter between the journals and 16 feet long over all. The two balance wheels are 30 feet in diameter and 10 inch face, the hubs of the same forming the cranks of the engine. Each wheel is made on 12 segments, and to each segment is cast an arm. The segments are held together by heavy keys and links, the whole being connected to the hub or center by 4 inch bolts passing through each arm and being keyed to the hub. The crank pins to which the side rods are attached are 9 inches in diameter by 9 inches long in the journals.

A brief description of the valve motion of this engine will be of interest to engineers. The admission and emission of steam in the two cylinders is accomplished by eight valves, four for the admission and four for exhaust. The admission valves are of the Cornish double-beat style and the exhaust valves of the American double-beat form. Each valve is independent of the other and is raised by a cam, attached to a shaft, on the end of which is an arm, connected to a main rock shaft, placed across both cylinders and moved by an eccentric, fixed on the fly wheel shaft. Each valve, by the construction of its connections, is lifted quickly and the exhaust remains open during the entire time of the piston strike.

Each admission valve is controlled by O'Neill's variable cut-off. This cut-off is so constructed as to drop the valve at any part of the stroke. It consists of a shaft moving on the valve-stem, and in each end of which is fixed a segment of a circle, resting on rollers, situated in the end of a block, sliding on the valve-stem and resting on the cams that raise the valve. These two segments are worked by an independent eccentric, moving with the piston of the engine, and, by sliding off the rollers, allows the valve to drop. By changing the position of the segments, with a right and left-hand screw, the time of the drop of the valve is altered at will. On one side of the air-pump is bolted a feed-pump for the boilers, which is worked from the same rock shaft. This feed-pump is 6 inches in diameter and 6 foot stroke. The condenser is placed in a vertical position in the channel of the air-pump, with injection on top, both air-pump and condenser being placed at the side of the expansion cylinder. The condenser is 36 inches in diameter by 8 feet high, fitted with spray injection pipe.

For this machinery there are eight boilers, arranged in pairs, which, however, are to run the hoisting engines also. They are horizontal, tubular boilers, 54 inches in diameter by 16 feet long, each being fitted with the usual safety valves, connections, etc. They are so arranged that any pair can be disconnected for the purpose of repairs, or steam can be used from one or all the pairs. In addition to the other precautions for economizing in fuel and steam consumption, the boilers are all placed *below* the engines, so that all the condensed water from the jackets or cylinders is returned to the boilers and that heat saved. This shows with what care the whole general plan has been carried out.

The main pump bob is 38 feet 6 inches long from the center of the pins and is 21 feet high. The main shaft of the bob is 21 inches in diameter between the journals, the wrought iron journals being 23 inches long and 18 inches in diameter. There are six diagonal braces made of wrought iron, 3 inches thick and 14 inches wide. The journal of the pins, connecting with the main pump rod, is 15 inches in diameter by 17 inches long. The main pitman rod, which connects with the wooden pump rods in the shaft, is 37 feet long. It is made of wrought iron, 15 inches wide and 5 inches thick at the upper end, decreasing to 1¼ inch thick at the lower end, all well bolted and keyed together.

The air pump is horizontal, and is driven by the main cross-head, working a cast iron rock-shaft by levers and rods. It is fitted with four suction valves and six discharge valves, made of rubber working on brass seats. This air pump is a fine piece of machinery, and weighs alone, with its fittings, 24 tons. The barrel is 36 inches in diameter by 6 feet stroke, lined with ⅛ inch brass. This air pump is specially designed to insure perfect action. The vapors rising from hot water can pass directly from the receiving valves to the delivery valves, and be forced out by the water upon the return of the piston, vapors always occupying the upper surface, a very important point in an air pump.

With the rest of the machinery are six plunger pumps, 14 inches in diameter and 10 foot stroke; also one 14 inch bucket pump. These pumps are very heavily built, being as strong as possibly could be made. They force the water up to the surface through a 14 inch tubing.

One can hardly get a conception of the massive proportions of this machinery without actually seeing it. The engines are designed to work up to 1,500 horse power, the initial cylinder being intended to run with a pressure of 130 pounds, and being made very strong for this pressure. There are on this machinery upward of 90 of Lonergan's patent oilers, all nickel-plated, besides two half gallon Siebert lubricators, and two oil pumps fitted to the cylinders. The engine is fitted with the necessary gauges, indicators, revolution register, etc., all silver-plated and mounted on a handsome frame. The engine will be very ornamental when finally in place, as a large proportion of it is bright work, which has been beautifully finished. The rougher parts, such as the frame-work, etc., will be neatly painted, as is usual. A nicely finished iron platform, with polished railings, is mounted on each side of the engine and extends across the front of the cylinders, for the convenience of the engineers and those desiring to see the entire machine in operation.

On each side of the slides is a brass plate. One of these is emblematic of the great industry to which the machinery is devoted. In the center is the figure of a miner at work in a drift, and surrounding it are objects and scenes incident to a miner's life—a miner's tent, flumes, timbers, etc. The other plate bears the following inscription: "Yellow Jacket Mining Co.; T. G. Taylor, Superintendent; W. H. Patton, Constructing Engineer; Prescott, Scott & Co., Builders, 1878."

The engine combines all the modern improvements in engineering, so as to get a direct motion from the engine to the pumps, and have a rotating motion for all the steam valves. To accomplish this, the plans carried out were designed by Col. J. G. Fair, Superintendent of the "bonanza" mines; W. H. Patton, Assistant Superintendent and Constructing Engineer; T. G. Taylor, Superintendent of the Yellow Jacket Mine; J. G. West, Chief Engineer of the same mine, and Irving M. Scott, one of the proprietors and General Superintendent of the Union Iron Works. The detailed drawings were worked out by Mr. Eugene O'Neill, Chief Draughtsman of the Union Works.

The result so far reflects credit on all concerned, as well as to the foundry interests of the city. The quality and style of machinery speaks for itself in terms complimentary to the projectors and constructors.

The foundations for this heavy machinery are already being laid, and will shortly be completed. They are made of solid masonry work, 30 feet in depth. The anchor rods, and bolts to pass through the bed frames, are 26 feet long and built into the masonry.

The new shaft of the Yellow Jacket Mine, on the Comstock, on which this machinery is to be placed, is now down about 1,300 feet, and will be sunk to at least 2,300 feet. The main east drift on the 2,200 foot level of the mine is directly under the line of the new shaft, so that they will raise from that level to expedite matters. When the connection is completed, all the water from the mine will be raised through this shaft. The cost of this new shaft, including the machinery described, is estimated at $1,600,000. This includes all the pumping engines and fixtures, hoisting engines and equipment, compressor and fixtures, hoisting rig for the new pump shaft, etc. The whole is the finest piece of work ever built on this coast, being in Col. Fair's best style. The machinery is of a capacity sufficient to work the shaft to a depth of 3,000 feet.—*Mining and Scientific Press.*

THE U. S. MINT, PHILADELPHIA, PA.

The United States Mint in Philadelphia is a handsome white marble, two storied structure, with an imposing Grecian portico, supported by high Doric columns, and approached by a flight of wide marble steps. The Philadelphia Mint was founded April 2, 1792; the first director was appointed by President Washington, April 14, 1792, and the present building, which is situated on the pleasantest part of Chestnut street, near Broad, was first occupied on the 23d of May, 1833.

RECEIVING ROOM.

In the centre of the building is the receiving room. It is surrounded by the offices of the director, the chief assayer and the smelting department, with which it has easy access. Much depends upon the absolutely exact and nice working of the receiving department, through which all the material used in the Mint first passes, for it is only from the perfect administration of this department that the losses and gains of the minting process can be realized. The work of the delivery department must at each month's balance tally with the receiving registry, and if there is a deficiency in the accounts an investigation follows and the discrepancy is discovered. The nugget, pure or mixed with quartz; old, unused or worn-out plate; ancient jewelry; bars from the assay offices of the government and from foreign countries, and refuse metal in every conceivable form are received at this point, to be transmuted into beautiful bright coin, to be sent upon its errand of good or evil, as the medium of exchange for the business of the world.

SCALES TO WEIGH A GRAIN OF DUST.

The consignment, whether it be small or large, is first carefully weighed, and the weight, character of metal and number of the consignment are entered upon the books of the receiving department and also upon a tabulated statement of each day's proceedings. As exactitude is of paramount importance in this, the initial stage of the work, it is requisite that the officials on duty should be painstaking and trustworthy men, and that they have at their command means of weighing their valuable receipts to a perfect nicety.

In this room are three sets of scales, varying in capacity from 100 ounces to 6,000 ounces, and so perfect is the adjustment of these beautiful pieces of mechanism that the largest scale will indicate with ease the weight of the hundredth part of an ounce. It will actually weigh a grain of dust. A breath will tip the beam, and airtight glass cases are necessary to inclose the instrument. If you put a piece of blank paper on the scale and then write your name on the paper, these balances will indicate the difference in weight. These scales are the very perfection of mechanical workmanship. The arms of the instruments hang on agate pinions, the metal portion having been made of case hardened steel, and although they have been in constant use for thirty-two years, are as accurate in their indications as when first placed in position. They are but a portion of the work of the late Franklin Peale, the well known mechanician of his day, who for the best portion of his life devoted himself to the perfecting of the mechanical appliances of the Mint. Each package as received is kept separate, and as soon as weighed and registered is sent to the deposit melting room.

THE MELTING ROOM.

Here is commenced the process of testing the intrinsic value of the metal received. If the package is small it is sent in bulk, but if large a portion only is taken for refining. In this room are four furnaces, kept in constant use in the refining process. It is the province of the management of this room to take from the gold or silver received for refining all refuse matter or baser volatile metals, in order that the assayer may reach by assay an approximation of the inherent value of the consignment. The furnaces are small and charcoal is solely used, in order to avoid the presence of sulphur, which is destructive to the finer metals. Niter, soda and common salt are used as purifiers, and at times powdered charcoal. Sometimes, but rarely, other means have to be resorted to. This is when, as the bars come to the Mint from private or public assay offices, it is found that the sulphides of the baser metals have been permitted to remain in the bar. In such cases the employment of corrosive sublimate must be resorted to. The excess of oxygen in this material acts with lightning rapidity upon the extraneous matter, and the purification is thorough. It must be used with great care, for it is so active an agent that if not quickly and delicately handled volatilization of the metal will be the result and a consequent loss.

THE MELT.

The condition of the melt must be watched at regular intervals, in order that at the instant of purification the liquid metal may be poured. The contents of the crucible are poured into a shoe or open mould, and when cooled the ring, or nugget, is separated from the flux and returned to the receiving room. From this piece a sufficient quantity is taken to make an exact assay of its value, either by acid or cupel process, and upon the percentage value of this test the depositor is paid for his consignment.

All the deposits after assay are thrown into one bulk, out of which large melts are made for the main melting rooms, and from each melt is again taken a separate assay, by and through which the chief assayer determines and keeps at standard the quality of the coin that is minted. It is through this delicate process that each and every ingot of silver, gold, or copper is brought up to the standard of fineness set by law.

THE ASSAY.

This form of detection of the true value of the precious metals is to the outside world generally a mystery, and few are permitted to see the operation as conducted at the Mint. A plain statement, devoid of technicalities, will be of interest to those who cannot gain access to the inner workings of this establishment.

ASSAYING GOLD.

The piece of gold which is taken from the bar is beaten out and rolled into a thin plate, and from it is weighed a half gramme, the customary quantity for gold being about 7·7 grains, troy. The weight used in approximating the quantities is stamped 1,000, and all the lesser weights are decimal divisions of this sum down a ten-thousandth part. Silver is next weighed out for the alloy, for as the gold piece should contain 900-1,000 of gold, the silver used must be three times this proportion, or, 2,700-1,000. The lead used in the process is in thin sheets cut into square pieces, weighing ten times as much as the gold under assay. This sheet of lead is made into the form of a hollow cone, and into this is introduced the piece of gold to be assayed and the proper proportion of silver. This combination of metal is placed in a cupel or small dish made of bone ash, an article capable of absorbing the baser metals, and placed in a furnace heated to a bright red heat. The cup is permitted to remain until the surface of the melted metal has become bright. This indicates that the whole of the base metals have been converted into oxides and are assorted by the cupel. The button thus produced is, when cool, pressed into a sheet between cylinder rollers, and annealed at least twice, and is then made into a little roll termed a "cornet." The silver that remains is extracted by the use of sulphuric acid. This is effected by the use of the platinum apparatus, an English invention. It consists of a small tray, technically called a basket, made of platinum, divided into twelve small compartments, each of sufficient size to hold a cornet. In this is boiled nitric acid, which extracts the silver and leaves the gold free from admixture with any other metals. The gold is then left in its purity. But, while it may be pure gold, it still may not be up to the standard of the quality required by the Mint, for there is as much difference in the quality of pure gold as there is in any other metal—in iron obtained from different mines, for example. The gold obtained from the Georgia mines is the gold nearest purity, being purer than even the California gold. The final weighing of the little coil determines the fineness of the original sample by proportional weights in thousandths. The arrival at a just conclusion is by comparison in weight with a cornet of chemically pure gold. The entire process is beautiful, and the delicacy to which it has been brought exhibits the rapid advance made in metallurgical chemistry within this century.

THE SILVER ASSAY.

Granulated silver is used in the silver assay, as it has been demonstrated by this Mint and the Mint of Paris, France, that out of a granulated mass the same fineness results, whether by assaying a single granule or a number together. From a sample of silver prepared in this way the weight 1,113-1,000 of a fixed, very small quantity is taken, which is dissolved with nitric acid. Into this solution a pipette full of standard solution of salt is introduced and it instantly produces a white precipitate which is chloride of silver, containing of metallic silver 1,000 parts. (A pipette is a small vial-shaped glass vessel.) To make this chloride subside rapidly the liquid should be violently shaken, and this is

done by a mechanical arrangement, the time occupied being about twenty minutes. If the entire amount of silver is not precipitated an introduction of a portion of the solution is made capable of precipitating a thousandth of silver and a white cloud of the chloride will be seen. This is repeated until the liquor is clear. If in this operation three measures of the decimal solution is effective it will show that the 1,115 parts of silver contained 1,003 parts of pure silver. All the excess was impure matter. This department of the Philadelphia Mint has been brought to the utmost limit of present metallurgical science. As confirmative of their evident superiority an incident would not be inappropriate.

AN INTERNATIONAL DISPUTE.

Some years ago, when but moderate quantities of gold were mined in this country, the Mint depended for its supply mainly upon the receipt of British coin. It was discovered by an assay that a consignment from England was below the English standard. Notice to this effect was served upon the Royal Mint at London. The assertion was strenuously denied on their part, and insisted upon just as firmly by the officials of the United States Mint. The controversy, which was animated, gave rise to the formation of a committee of investigation on the part of the London Mint, and the result completely sustained the allegations of the American experts. From that date there has been no questioning of the decisions of our Mint masters.

THE SEPARATING ROOM.

The separating room occupies the greater part of the western side of the building on the second floor. The gold and silver in large masses are separated from each other after samples have been once melted and assayed. In separating and purifying gold a certain quantity of pure silver is added. The whole is then immersed in nitric acid, which dissolves the silver and leaves the gold pure. The silver solution is drawn off and the gold is left at the bottom of the tub. In preparing silver the mass is melted and granulated and dissolved in nitric acid. It is then a chloride, and contains all of the baser metals. The chloride is precipitated by using common salt, and rendered into a thick, creamy mass. By putting zinc on the precipitate, it becomes metallic silver, and washing and melting brings it to virgin silver.

MELTING.

In this department there is a force of forty-one men engaged in smelting gold and silver or in subsidiary operations. Of this force there are seven melters and seventeen helpers engaged solely in melting silver. This gang are now working exclusively upon the preparation of the silver dollars. It is claimed by Professor Booth that he can melt daily with this force ingots sufficient to make $50,000 silver coin. This is their full capacity of work within ten hours, and is larger than has ever been executed in this Mint or in any other. By working overtime with the same force and with the same furnaces they could produce $75,000 daily, or, lastly, by using the additional furnaces and overtime, $120,000 per day might be produced. This would increase the ratio of production from $1,000,000 per month to $2,250,000 to $2,500,000 per month.

It is curious to note the amount of work $1,000,000 per month involves. The $90,000 production per day weighs 6,170 pounds, and being handled sixteen times a day makes 98,700 pounds. The iron moulds, weighing 40 pounds each, carried 64 times for each melt, makes 76,800 pounds handled, the total being 175,520 pounds, or 78 tons. A melt of silver from the present pots averages 64 ingots, weighing altogether about 3,000 ounces. The size of the ingot is 13 inches in length, 1¾ inch in width, and one-half inch in thickness, weighing about 44 ounces troy. These ingots are rolled down for the new dollar to a thickness of 82-1,000th of an inch, and cut to a diameter of 1½ inch. The keeping up of the average of purity in the smelting is done by a constant succession of granulated assays. In a melt after the first two ingots they pour a granulated assay, and next to the last another assay. If the two do not agree the melt is condemned. The silver now in use is the Doré silver, from the Comstock lode. It seldom needs refining, and is taken as a rule from the bar to the melting pot.

THE LOSSES.

The losses in the melting department allowed by law is, in silver, ·0015th, or 1½-1,000, and the actual loss is but 77-100ths of 1-1,000th. In gold the legal allowance of loss is 1-1,000th, while the actual loss is but 44-100ths of 1-1,000th. This is the exhibit of the melting department in the month of January, when about $5,000,000 in gold was melted. The above figures are considerably reduced when the sweepings are gathered and refined and brought into the general account. The chief melter, Professor Booth, is never satisfied until the actual loss is reduced to one-fourth of the legal allowance.

ROLLING.

The ingots of metal pass from the melting rooms directly into the rolling room to be milled into suitable sizes for the planchet or cutting process. The cutting presses are in the rear of the rolling mills. There are nine of these machines, each capable of cutting 225 pieces per minute. They can all be adapted to any size coin, as they can be regulated by the size of the movable punch. Samples of each series of cuttings are carefully weighed before they are permitted to be used. The planchets after being adjusted to the requisite weight are carried to the cleaning room, and are then ready for the final process.

THE DIES.

The dies used in coining are at present made under the direction of Mr. Morgan, a former employé in his special department in the Royal Mint of London, a gentleman of rare ability as a designer and engraver, and of fine artistic taste. The new coinage, which may be expected this week, will illustrate his abilities in no measured degree. The mode of preparing the dies is slow, requiring great care, first in the separation of the material, and second in the annealing and adjustment for the blow. Each die, under ordinary usages, is subject to one blow a day; but Mr. Morgan, in order to facilitate the production of dies to meet the present urgent calls, has undertaken to give them two blows every twenty-four hours. This is but an experiment and may prove a failure. In preparation for the blow the die must be brought gradually to a cherry-red heat in a charcoal furnace and permitted to gradually cool within the furnace, the operation occupying from sixteen to twenty-four hours. The blow producing the impression is from a hydraulic press, exerting a power of about one hundred tons. It is not a rapid blow, but may be truly termed a pressure exerting a quick but not percussive power. A percussion always crystallizes the metal, an objection entirely avoided by this application of force.

A SLOW PROCESS

The preparation of the dies, as will be seen by the above description, must be slow, and, taking into consideration the time necessarily occupied in their adjustments, it would be impossible, under the most favorable circumstances, that coining can begin prior to the 14th of this month, if then. The first delivery of ingots for the coinage was made on Monday, and blanks are being cut rapidly, the chief coiner, Mr. Bosbyshell, giving as his opinion that already there are sufficient on hand waiting stamping to amount to $100,000. The Mint is being placed in effective condition to do all that its contracted quarters will permit toward supplying the demands that the bill calls for. Ninety thousand ounces of silver are now delivered from the refining and melting department, an amount that will produce somewhere near $60,000.

The peculiarity of Mr. Morgan's work is the bringing into relief, with a slight depression, that which was considered unattainable except by strong lines and deep work. The secret of effects is in the sharp lines used in the delineation of the figures, which brings the lights and shadows out boldly, and thus gives the appearance of heavy work. Aside from the relief this light cutting gives to the die in its work, the coin is more rapidly removed from its bed after completion by the "feeders."

COINING DEPARTMENT.

Occupying the larger portion of the eastern floor, it is considered the most interesting part of the operations of the Mint. There are eleven presses in this room of different sizes, varying according to the work required of them. Each press is capable of coining 120 pieces per minute, but the average run is but eighty, as beyond that number the danger of injury to the press in case of accident is much increased. The larger presses, of which there are five, will only be used in the coining of the new silver dollar, and at the rate of eighty pieces each per minute there will be produced 400 pieces a minute, or 24,000 an hour. On each silver dollar, to create a perfect impression, a force of eighty tons is used, and yet the machines are so delicately adjusted that the observer deems the assertion as bordering on the marvelous. The impressions on both sides of the coin are made with one motion of the press. The steel die is fastened upon what is termed a stake, and placed on the bed of the press, surrounded by a collar. Working directly over the lower die the obverse die is fixed, and it is from this portion the needed pressure is regulated. Two iron arms called feeders catch the coins as they drop from the brass tube, which is filled with planchets, grasp it and place it on the lower die. At the instant this die sinks below the collar the upper one descends upon the piece, its impression is given, and in an instant the completed piece is caught by the feeder, removed, and another planchet takes the position.

This is the finishing process, and the coin, bright and sparkling, is taken to the counting board to be reckoned, weighed, and shipped to its destination. It may be observed here that in this, as in all other departments of the Mint, the weighing process and an exact entry of the same is of vital necessity. The gold and silver coins, when completed, are transferred to the chief coiner's room, where they are put up in packages ready for delivering to the Treasury

INADEQUATE FACILITIES.

The assay, refining, milling, and coining departments of the Philadelphia Mint are much in advance of the capacity of the melting furnace. From the statement of Professor Booth in another portion of this article it will be perceived that he is managing his portion of the service with inadequate facilities, more especially in the contracted space wherein he is required to do his extensive operations. The portion allotted to the melting operations is in surface but little larger than that apportioned to the work of coining, yet in this limited space he is expected to move forty-one men, handle over six thousand pounds of silver, cool and transfer from place to place 76,800 pounds of iron moulds, covering in all about seventy-eight tons, in a single working day of ten hours. But for the most judicious management it would be impossible to accomplish the task, and there are times when much loss of time is incurred from want of space. A careful observation of the workings of this branch of the service will show the positive need of more room, that the melting shall keep pace with other branches, and save much valuable time, besides yielding larger products. The California Mint, with a capacity double that of the Philadelphia Mint, is only doing the same amount of actual work. The value, of course, is greater, as the work is mainly in gold, but the number coined has not been at any time in excess of the Mint at this place. This speaks volumes for the management of the parent Mint, and under the circumstances the Superintendent should not hesitate to ask for greater facilities, and were the matter properly presented there is but little doubt that so reasonable a request would be granted.

THE NEW DOLLAR.

The coining of the new dollar was begun this morning. Two of the large presses are in use, and will be pushed to their full capacity, in order that there can be ready for delivery on Thursday morning $150,000.

The distribution of the first of the coinage to-day is worthy of note. Six copies were beautifully finished. Three were sent to Washington, destined for the President of the United States, the Secretary of the Treasury, and Dr. Linderman, Director of the Mint. One is in possession of Governor Pollock, Superintendent of the Mint; one in the hands of O. S. Bosbyshell, chief coiner, and, by the kindness of Mr Bosbyshell, your correspondent became the recipient of the last of the series. The officers of the Mint are Hon. James Pollock, Superintendent; Professor James C. Booth, melter and refiner; N. B. Boyd, assistant melter and refiner; William E. Du Bois, assayer; Jacob B. Eckfeldt, assistant; O. S. Bosbyshell, chief coiner; William Barber, engraver, and George S. Morgan, assistant engraver and designer of the new silver dollar.—*N. Y. Herald*, March 13.

SOURCE OF WATER IN THE MINES.

A NOTABLE feature of the great porphyry bed in which rests the Comstock system of quartz lodes is its vast longitude from north to south. This remarkable zone of metamorphic rock has been clearly traced from Pyramid district on the north to a point east of Empire City on the south, and, in fact, there are vestiges of it southeast of Genoa. The general trend or strike of the mineral-bearing quartz lodes through the great porphyry belt is nearly north and south, but there are numberless curves and deflections in the system which give to each mining locality a sort of isolated quartz crescent, such as appears in the mother lode at Gold Hill and Virginia. These bendings and distortions were doubtless occasioned by lateral volcanic disturbances, long after the deep fissures were formed and filled with quartz and minerals. In addition to the manifest disturbances outside of the porphyry zone, the ledges were, probably in the miocene period, bent, crushed and distorted by eruptive dikes of trachyte and andesite, which came up in various portions of the metamorphic bed. One of these eruptive dikes followed the sloping base of Mounts Davidson and Butler, and came out on the western flank of the propylyte mass, while another, of greater magnitude, was extruded further toward the east. These eruptive dikes are now plainly traceable, and afford a ready clew not only to local disturbances and faults in the quartz veins, but they also account for the remarkable crushed condition of the once solid ore chambers. Every Comstock miner is aware that most of the quartz veins here are literally crushed to atoms before extraction, and instead of the quartz retaining its original compact, flinty texture, it is little else than a mass of friable pick-rock. To this peculiar crushed condition of the Comstock quartz veins may be attributed the vast inflow of water which has so long baffled the skill and energy of mine-owners. For many ages water from the surface has been constantly percolating through the fractured rocks, penetrating and saturating the crushed material of the ledges, until the entire fissure, for many leagues in longitude, became a vast reservoir of water. As the great porphyry bed in this locality is firmly walled on the east by an unbroken wall of trachyte, and on the west by the solid base of Mount Davidson and Mount Butler, it is not reasonable to suppose that a supply of water could reach the Comstock from either Washoe Valley, the Steamboat Springs, or the Carson river. The supply evidently comes from the lode itself, and this fact encourages us to believe that constant pumping will ultimately exhaust the aqueous annoyance. It may be urged against the theory here advanced that there was a depth of more than a thousand feet in the Comstock where the lode was almost entirely devoid of water. In answer to this we have only to refer to the vast longitudinal extent of the great zone. Even if surface percolation did not occur in this immediate section of the system, water may have entered the fissure at other points many miles away, and in the lapse of centuries gradually saturated and filled the entire mass of crushed and distorted minerals in the great fissure.—*Virginia Enterprise.*

THE NEW YACHT INTREPID.

A NEW keel schooner yacht built for Mr. Lloyd Phœnix is receiving the finishing touches of the mechanic in this city, the particulars of which we find in the N. Y. *Herald*. Her lines were drafted by Mr. A. Cary Smith, whose lectures on naval architecture have recently attracted so much favorable attention.

She has something of the English type in her general appearance, which is probably derived from her twelve foot of overhang at the stern. The lines, however, are purely American and run rather sharp forward. Mr. Phœnix was formerly an officer in the United States Navy, and as he takes much pleasure in off shore cruising the bulwarks have been made rather higher than usual, running from two and a half feet to three feet in height. Talking with Mr. Poillon, the latter gentleman said that the work on this yacht was executed by first class mechanics, and the material the very best that could be obtained. The timber used was chiefly white oak, hackmatack and locust. The deck was of selected white pine, without a knot from stem to stern, and the keel and planking were of white oak. She was copper fastened, and locust treenails were used to the load water line. The hatch combings were all mahogany, and the rigging of the best charcoal wire. She will take between sixty-five and seventy tons of ballast, of which twenty-five tons of lead has been moulded and stowed between the frames. The freeboard is three feet eight inches from water line to plank shear, and she will draw about eleven feet six inches in the water.

THE CABIN.

The deck is flush and the companionway leading to the saloon is situated aft of the mainmast. There is a hatchway further aft with a ladder leading down to the staterooms destined for the sailing master and first officer. These rooms are located to the right and left of the ladder and are each 6½ feet by 8 feet in dimensions. They have no connection with the cabin. The entrance to the main saloon is through doors passing both to the right and to the left of the mainmast. Leading aft from the foot of the companionway there is a passage on the port side, with a stateroom 10 feet by 8 feet on the starboard side, and another 10 feet by 6 feet on the port side. At the end of the passage is the after cabin, measuring 11 feet by 12 feet, which is probably designed for a smoking room. The main cabin is 16½ feet by 16½ feet and lighted by a skylight measuring 8 feet by 4 feet. Forward of the main saloon, on the port side, is another stateroom 7 feet by 7 feet, and on the opposite side is the bathroom, pantry and steward's room. A doorway leads into the galley, which takes up the whole width of the vessel, with the foremast passing through the center. The ice chest is on the starboard side. Forward is the forecastle, about 24 feet in length and accommodation for ten men. The cabin is to be painted white and finished in gold. The furniture and berth frames will be of mahogany.

The following are the principal dimensions·

DIMENSIONS OF HULL.

	Tons.
Carpenter's tonnage	276 64-100
Old measurement tonnage	260 67-100
Displacement (11½ feet draught)	203

	Feet.	Inches.
Length on water-line	100	07¼
Length over all	113	08¾
Width of beam (outside plank)	24	01¼
Depth of hold (carpenter's)	11	07¼

DIMENSIONS OF SPARS.	Ft.	In.
Length of mainmast	88	00
Length from deck to hounds	66	06
Length of head	09	06
Diameter at partners	01	08
Diameter at hounds	01	07
Diameter at neck	01	01½
Diameter at cap	00	10
Length of foremast	84	06
Length from deck to hounds	63	06
Length of head	09	00
Diameter at partners	01	08¼
Diameter at hounds	01	07½
Diameter at neck	01	01½
Diameter at cap	00	10
Length of bowsprit	29	00
Length of stem to end	20	00
Diameter at bed	01	02
Diameter at end outboard	01	00
Diameter at end inboard	00	10
Length flying jibboom	39	06
Length cap to hounds of flying jibstay	15	11
Diameter at the cap	00	10
Diameter flying jibstay hounds	00	09
Diameter jibtopsail stay hounds	00	07
Length of foretopmast	41	00
Length of heel to withe	36	00
Length of pole	05	00
Diameter at withe	00	10
Diameter at hounds	00	08
Length of fore gaff	27	03
Diameter at the middle	00	07
Diameter at the jaws	00	07
Diameter at the end	00	05
Length of fore boom	29	00
Diameter at the middle	00	08½
Diameter at the jaws	00	08½
Diameter at the end	00	05
Length of maintopmast	41	03
Length of main heel to withe	36	03
Length of main pole	05	00
Diameter at withe	00	10
Diameter at hounds	00	08
Length of main gaff	36	06
Diameter at the middle	00	08½
Diameter at the jaws	00	07½
Diameter at the end	00	05
Length of main boom	60	00
Diameter at the middle	01	01
Diameter at the jaws	00	08
Diameter at the end	00	06
Length of foretopsail sprit	44	06½
Diameter at the middle	00	06
Diameter at the ends	00	03
Length of foretopsail club	25	00
Diameter at the middle	00	05½
Diameter at the ends	00	03
Length of maintopsail sprit	47	00
Diameter at the middle	00	07
Diameter at the ends	00	03

AREA OF CANVAS.	Yds.
Area of mainsail	1,178
Area of foresail	579
Area of forestaysail	353
Area of jib	305
Area of flying jib	312
Area of jibtopsail	330
Area of maintopmaststaysail	450
Area of maintopsail	192
Area of foretopsail	180
Area of large maintopsail	172

Mexican Antiquities.—At a recent meeting of the St. Louis Academy of Sciences, Mr. J. A. Dacus presented drawings of the ruins of a vast palace at Xayi, Chiapas, Mexico. Some discoveries have just been made in the subterranean portions of this ruin. It is supposed that a library has been found, perhaps of sacred writings.

HOW TO BUILD A CHEAP CATAMARAN.

The accompanying illustrations, taken from plans of a catamaran in service on San Francisco bay, will give an idea of how such a craft may be constructed cheaply and with little labor. The runners, A A, Fig. 2, are made of three-quarter stuff, strengthened with internal cross-pieces; are put together with galvanized wrought iron nails, and the joints calked with white lead laid on before being put together. If carefully made there is no need of any opening for bailing; but after hard usage, if leakage occurs, they may be tapped by a small bit underneath and plugged. The runners are 13½ ins. high, 1 ft. wide, and 15½ ft. long. The scow shape at the bow and stern is adopted because easier to make, and practically it makes little difference as to resistance whether the runners are sharpened in this way or laterally, while the continuation of the straight longitudinal lines is an advantage as regards weatherliness, and the upward sheer at the bow helps to keep the craft dry. In putting the runners together, set the side pieces, bottom side up, on a true surface, nailing on temporary cleats to hold them in position. The bottom board, which should be a little thinner than the other parts, is then placed on the sides, having been previously dressed into shape as closely as possible. Begin nailing at the center and work toward the ends. When the point where the bend begins is reached, place several thicknesses of wet rags upon the bottom board and pass a Lot iron over them. This expedient obviates the necessity of a steam box. Before finishing the nailing the board should be firmly clamped into place, to prevent springing. When the nails are all in, the clamps may be removed.

With the shape shown the total buoyancy will be about 1,643 lbs., the catamaran being calculated to carry, in addition to its hamper, two persons, although on a pinch it will take four or even five. With a crew of two, the draught should be 4 ins. The arrangement of cross-beams, B B, 2 by 4 ins. each, and of the mast-step, C, open platform, D, etc., will be easily understood from the diagram, Fig. 2.

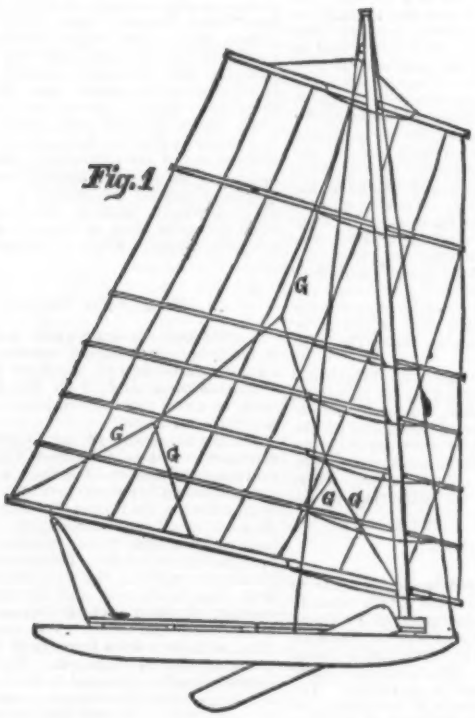


Fig. 1

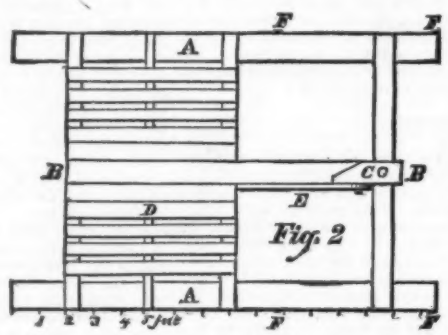


Fig. 2

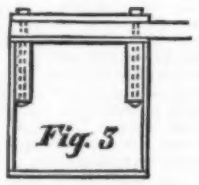


Fig. 3

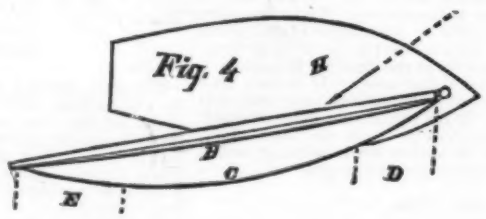


Fig. 4

CATAMARAN WITH MALAY RIG.

The space between the runners is 8 ft., and the outside beam is therefore 10 ft. This extreme width is not required for stiffness, but is convenient in giving more room, and materially assists the purchase of the stays. The cross-beams are secured to the upper surface of the runners by bolts and lags, or wood-screws, which pass through heavy longitudinal battens (see Fig. 3) inside the runners. The center board, E, is pivoted by a lag near its forward end and is forced down when needed by a halliard secured at the upper fore corner and led aft to a cleat in a convenient position.

The hull thus being accounted for, the motive part of the craft, in this case of decidedly peculiar but effective arrangement, is next to be considered. One of the most important points is the proper staying of the mast, it being evident that the step only secures the heel and assists very little in keeping it upright. When the enormous spread of canvas and its strong but unsteady lateral pressure are considered, it will be seen that the stays, upon which alone reliance can be had, must be carefully set up. At the four points F F F F stout wrought iron straps are let into the wood of the runners, and four wire stays, ⅜ in. diameter, are led from the collar on the mast to within 18 ins. and tautened by lanyards. If the stays are perfectly taut when in use, the mast will be kept sufficiently rigid.

The sail, which is of the original Malay type with a few Yankee innovations, is 17 ft. on the boom, 9 ft. on the gaff, and 18 feet hoist. It has five slats of pine, 2 ins. diameter at the middle and tapering at the ends, which answer the double purpose of flattening it and of obviating the necessity of ordinary reefing gear. The four lower slats are placed at intervals of 2 ft., the lowest the same distance from the boom, and the fifth is intermediate between the slat below and the gaff. The sail has 2 in. bands of heavy canvas sewed across it where the slats come, and the latter are made fast by fishline passed through pairs of eyelets at suitable intervals. A four-part lazy jack, G, which also acts as a topping lift, receives the sail and slats when lowered, and the whole comes home as compact as though reefed or furled in the ordinary manner. The halliard is of single purchase and rigged kite fashion to the gaff; the hauling part is passed through a fair leader at the foot of the mast and led aft. The sail slides on the mast by loose rope beckets, which permit the jib portion to swing forward when sailing free and throw the sail aft when close hauled. This greatly assists the steering, which is done by a sweep hung by a lanyard to the after cross-beam. A sweep is preferable to a rudder, as it can be used to paddle the catamaran about or as a scull when the sail is down.

A sail made on this principle is so flat that it admits of a course less than three points off the wind. In beating to windward its superiority is unquestioned, and the ease with which it may be shortened in an emergency commend it to use on other vessels than catamarans. Notwithstanding its queer appearance it is destined to become a favorite among yachtsmen when its merits are better understood. Slats may be added to any fore-and-aft sail along the lines of the reef-points with good results; or may be made to extend over the after half of the sail only, if convenience in shortening sail merely is desired. As regards the utility of flattening the sail as much as possible, every sailor understands the question practically; but perhaps a clearer conception may be afforded by a glance at Fig. 4, in which the common and slat sails are compared, as applied under the same conditions. In the slat sail the line B shows the contour of the baggiest portion, *i.e.*, between the slats, and the line C follows the curve of the belly of a common sail hauled well home. It will at once be seen that, the direction of the wind being as indicated by the line H, the portions E and D are worse than useless in propelling the boat, the former being a back sail and the latter part lying too close in the direction of the wind. Very frequently sails are so carelessly set as to belly much more than shown in the diagram, and with the utmost care the curve cannot be less, without support. This the rigid slats give. In the orthodox Malay rig a series of vangs hold each slat and the gaff in an exact line with the boom. For small craft such nicety requires too great a complication of running gear and is not necessary.

This form of catamaran is adapted only to comparatively smooth water and light winds. It may be used advantageously in shallow water and in hunting, or exploring creeks, etc. In a sea way the runners have a tendency to dip under, and the craft is wet. The former obstacle can be obviated by making the runners higher out of water forward, with a sharp sheer, or by adding a lifting plane between them; and the latter may be removed by building the platform solid and higher, with a washboard if desired. A low movable bench may also be added. From these hints, by aid of the engravings, the reader may construct for himself a powerful and efficient craft, modifying the plan according to whether it is intended as a racing machine or simply a cheap and comfortable boat.

A New Catamaran.—George Roahr, of New York, is at present busily engaged in building a catamaran for his own use. The craft, which is nearly completed, is composed of two outrigger boats, each 30 feet in length, 2 feet 3 inches depth of hold, and 2 feet 2 inches beam. The platform is 8 feet wide and 14 feet in length, and is fixed midway between the two outrigger boats, which are fifteen feet apart. The catamaran will carry a jib and mainsail rig, and when loaded will only draw nine inches of water. Mr. Roahr is finishing his craft in a most superb manner and expects that she will take no mean place in the forthcoming yacht races.

The Sutro Tunnel.—The Sutro Tunnel scheme is likely to be accomplished within five months. The tunnel is now within 1,700 feet of the east wall of the Comstock lode, which it penetrates at a depth of 1,800 feet. The whole length of the tunnel through the mountains will be four miles when completed. The dispute between the tunnel company and the mine managers about the compensation to be paid the former for the drainage of the water from the mines has not yet been settled, and is likely to hang fire for some time Should no understanding be reached by the time the tunnel is completed, Sutro says he will shut the gates and let the mining companies take care of their water. —*Boston Journal.*

THE NEW BRAZILIAN IRON CLAD "INDEPENDENCIA."

THE imperial Brazilian iron clad turret frigate Independencia has just completed her steam trials in a very satisfactory manner, and is being got ready for commission. Her history down to the present time, short as it is, has been of a most eventful character. She was designed in 1872 by Mr. E. J. Reed, C.B., F.R.S., M.P., in accordance with outlines laid down by a commission of Brazilian officers sent over to this country for the purpose; and the contract for building her was given to the late firm of Messrs. J. & W. Dudgeon, of Millwall. The work upon her was pressed forward, and she was brought into a launching condition in July, 1874. In launching, however, she met with a most unfortunate accident. She stopped at the end of the launching ways, with her aft part overhanging them to a considerable extent; and as the tide fell her bottom was forced up by the great pressure exerted upon it, and she laid like a wreck in the Thames. After great exertion her buoyancy was restored by temporary means, and she was towed away into the Admiralty dry dock at Woolwich. The work of restoration proved to be of a very formidable character, as the whole of the ship appeared to be more or less damaged with the exception of the mere ends. All the bottom amidships was stove in, including the outer and inner bottom plating, longitudinals, and transverse bulkheads; the decks were forced up, bulkheads crippled, and the pillars bent and distorted. The great longitudinal bending strain she had been subjected to had also broken her sheer.

In order to repair the defects it was found necessary to take out the whole of the bottom of the ship for a considerable portion of her length amidships and build it in anew, to remove the bulkheads, deck beams, etc., and renew or restore them, and to greatly strengthen the upper part of the ship by doubling the stringers and some parts of the deck plating, and also the upper strake of side plating. These extensive renewals necessarily involved great delay and expense, but they had scarcely been well commenced before the firm of Messrs. J. & W. Dudgeon were obliged to give up the contract. The Brazilian Government then intrusted the carrying out of the repairs, and the completion of the vessel in accordance with the building contract, to Messrs. Samuda Brothers, of Poplar, under the supervision of Mr. Reed, who designed her. Since this arrangement was made the progress has been very rapid, and the Independencia has been speedily brought into a state of readiness for active service. Just as she was complete, and was steaming from the Millwall Docks to Greenhithe on the 22d of December last in readiness for making her speed trials, she experienced another misfortune, which might have led to most serious results. As she approached Greenwich a key which connects the gear on deck for working the steering engine with the engine itself worked out of place, and, unknown to the pilot, the working gear became disconnected. The result was that the ship went ashore opposite Greenwich College, and remained there till the next tide. The place where she grounded was fortunately very level, and the great strength of her construction as she now is enabled her to be left high and dry at low water without showing any sign of straining or causing a leak. Her bottom is sheathed with two thicknesses of 3 in. planking and coppered, and the great stiffness thus given to the plating between the frames doubtless greatly assisted it to bear the great strain of grounding with safety. The Independencia was docked at Chatham on the 2d of January, and was then inspected by Mr. Reed, Mr. Samuda, Captain da Mota, who commands the ship, and the officers of the dockyard, and no damage could be observed except that a few sheets of copper had been rubbed off forward. The steering gear that gave rise to the accident was Forrester's, and the experience of the Independencia should teach manufacturers of machinery, upon which so much depends, to guard against the possibility of a breakdown, particularly when the cause is so easily preventable as in this case.

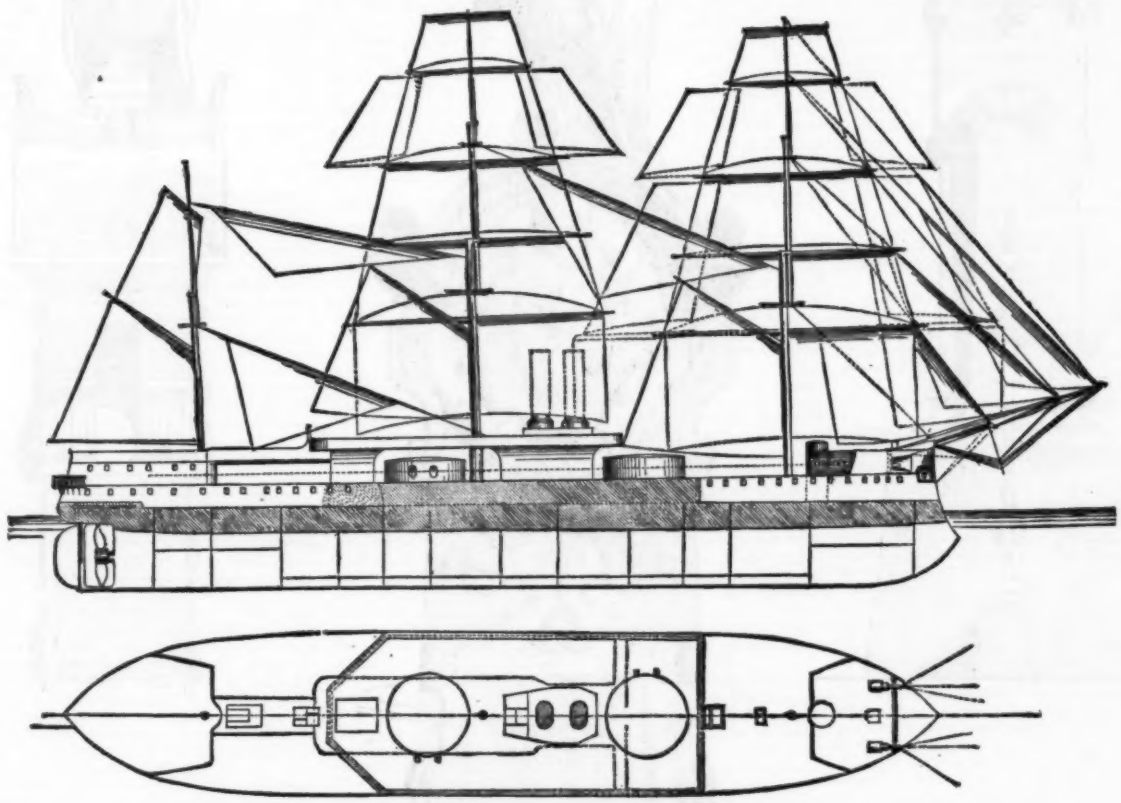
The Independencia, which we herewith illustrate, is 300 ft. in length between perpendiculars, 63 ft. in extreme breadth, and draws 24 ft. 9 ins. of water when fully loaded for sea. She has a load displacement of 8,960 tons. She carries two circular revolving turrets amidships, each of which contains two 38-ton Whitworth guns. The bases of these turrets are protected by an armored breastwork, which rises to the upper deck, and is of sufficient length to inclose the turrets, the boiler and engine hatches, the principal openings for ventilation, and the approaches to the magazines. Before and abaft this breastwork the armor plating is contained in the form of a belt round the bow and stern. The armor upon the water-line belt amidships is 12 ins. thick, with a teak backing of the same thickness, and upon the breastwork it is 10 ins. and 9 ins., with teak backing 10 ins. thick. The armor plating and backing are both bolted in the usual way to the skin plating of the ship, which is 1¼ in. thick, in two thicknesses of ⅝ in. plates. The top of the breastwork is protected by plating 1 in. to 1½ in. thick, and the deck at the top of the armor belt, before and abaft the breastwork, is protected by plating 2 ins. to 3 ins. thick. The funnel and engine hatches are completely protected on the breastwork deck by gratings formed of deep armor bars, and the openings in the deck over the armor belt are fitted with protective sliding iron shutters of the same thickness as the deck plating. The turrets are plated with armor of 13 ins. and 11 ins. in thickness, the former being placed upon that side of the turret which contains the ports, and the latter upon the other side. This armor is worked upon teak backing of a corresponding thickness, and the whole is secured to the plating of the turrets, which consists of two thicknesses of ⅝ in. plates.

The armament consists of four 38-ton guns, two in each turret, made of Sir J. Whitworth's compressed, when fluid, steel, and rifled upon the hexagonal system. These guns are mounted upon carriages and slides made by Sir W. G. Armstrong & Co., and are worked by hydraulic machinery. They are loaded by the same means, in the manner first applied to the turret of H.M.S. Thunderer, and since adopted in H.M.S. Dreadnought and Inflexible. In addition to the turret guns there are two 7-inch Whitworth guns mounted right forward under the forecastle behind an armored bulkhead. The 9-pounder boat guns are mounted at ports cut in the after end of the flying deck amidships for repelling boat attack, and mitrailleuses are mounted on the poop and forecastle for clearing the deck of boarders.

By this description it will be seen that the Independencia is one of the most powerful ships afloat. Her arrangement of armor plating is somewhat similar to the Dreadnought, and its thickness is little inferior to the Devastation and Thunderer, while her armament of Whitworth guns is more formidable than that of either of those ships. But instead of depending for power of locomotion upon steam alone, as the above-named ships do, the Independencia has been made a fully rigged ship. She is not deficient in steam power; but, on the contrary, she can steam one knot per hour faster than the Devastation or Thunderer, and the Independencia also possesses the very desirable quality of being able to cruise under sail. In our service we have only had two large sea-going turret ships designed to cruise under canvas, viz., the Monarch and Captain. The Monarch has been very successful as a sea-going ship, but she is only protected by 7 ins. of armor plating. The Captain was notoriously lost through a failure in carrying out a system of construction which becomes dangerous when certain limitations are neglected. In both these ships great difficulties had to be overcome in order to combine a great range of fire from the turrets with the rig and deck fittings required for cruising under sail, and they were overcome very successfully. But full rigged turret ships have gone out of favor in this country, and we have lately been relying entirely upon steam power and a large coal supply for the means of cruising.

In the Independencia a bold attempt appears to have been made to combine the offensive and defensive powers of our Devastation and Thunderer, and a higher speed than theirs under steam, with the rig and sailing qualities of our broadside ships. It is this feature which makes this powerful Brazilian vessel especially interesting. She has a forecastle forward, containing, as we have said, two 7-in. Whitworth guns, and also an armored pilot tower from which the ship may be worked in action. The head sails are worked from this forecastle and the bowsprit run in upon it. Just abaft the forecastle is the foremast, the shrouds and backstays to which are fitted so as to be readily let go and brought in toward the middle line in clearing away for action—all except two shrouds of larger size than the others, which will be allowed to remain and take their chance of being shot away. Between the turrets and overrunning them is a hurricane deck somewhat similar to the Devastation. It is about one-half the breadth of the ship, and extends from the fore-turret to abaft the engine hatch, being supported by the casings round the boiler and engine hatches. Upon this deck is fitted a rifle-proof house which contains the steering apparatus and appliances for working the ship, the boats, hammocks, steam winch, ventilating shafts, etc. Upon it are also two electric lights for use by night. The hurricane deck is narrowed abaft the engine hatch and continued to the poop. The standard compass and steering-wheel are fitted upon the continuation of the hurricane deck. The mainmast is placed between the funnel casing and the after-turret. The ropes connected with it are led down through openings in the hurricane deck to the upper deck and worked upon the latter, the mast being kept well within the line of fire. In clearing away for action the shrouds and backstays are all let go, as for the foremast, except two, and the ropes round the mast are all gathered up on to the hurricane deck. The mizzen mast is on the poop, from which all the ropes connected with it may be readily worked.

The difficulties in connection with the rigging have been ingeniously overcome, and there seems to be no reason why the Independencia should not be effectively maneuvered under sail. All other obstructions upon the deck and the bulwark plating—which is fitted to turn down over the side—can be readily cleared out of the way, and when all is ready for action the turret guns can command a range from abeam to within a few degrees of the fore and aft lines either way, as will be seen from the plan in the cut.



THE NEW BRAZILIAN IRON CLAD INDEPENDENCIA.

We have mentioned the Captain in connection with this ship, and it may be well therefore to point out that the fundamental difference between these two ships lies in their proportions, the Independencia being 20 ft. shorter and 10 ft. broader than the Captain, and having 5 ft. additional freeboard. This increased beam and freeboard must represent a very great excess of stability and of power to carry sail in the Independencia as compared with the Captain.

The engines are by Messrs. John Penn & Sons, and drive a single screw. They consist of one pair of cylinders 127 ins. in diameter, with 47 in. trunks, making an effective diameter of cylinder of 118 ins. The stroke is 4 ft. 6 ins. The guaranteed number of revolutions was 70, and the horse power 8,500. The boilers are eight in number, working at 30 lbs. pressure. They are contained in two separate watertight compartments, four in each; so that in the event of one boiler-room being flooded, the other could still be worked. The boilers are 18 ft. in length, 10 ft. 6 ins. wide, and 12 ft. 9 ins. deep, and each contain five furnaces 3 ft. in width. The propeller is 26 ft. in diameter, and has 23 ft. pitch. The shaft is 20 ins. in diameter.

The preliminary trial of the machinery was made at the Nore on the 31st of December last, and the official speed trial on Saturday, February 2d, over the measured mile at the Maplin Sands. The result of the trials was most satisfactory, a mean speed of 14·6 knots per hour and a horse power of 9,000 having been obtained. It was stated by Mr. John Penn, Jun., who conducted the trial on behalf of his firm, that this is the greatest power that has been indicated by any war ship, and no doubt this is the case. One of the nearest to it is H.M.S. Alexandra, which indicated 8,600 horse power on trial.

The Independencia is now very nearly ready for trying her sailing qualities, and the working and firing of her guns at sea. She is such a very powerful ship, and contains so many novelties and resources, that her further trials cannot fail to prove exceedingly interesting and instructive.—*Engineering.*

MONUMENT WITH WROUGHT-IRON INCLOSURE.

THIS monument, designed in the style of German Renaissance, by Professor C. Walther, Nuremberg, is executed in fine grained freestone, the twisted corner columnets of the railing are wrought of square rod-iron, the other upright posts being toothed by cuttings with the chisel.

THE TECHNOLOGY OF THE PAPER TRADE.*

By WILLIAM ARNOT, F. C. S., Edinburgh.

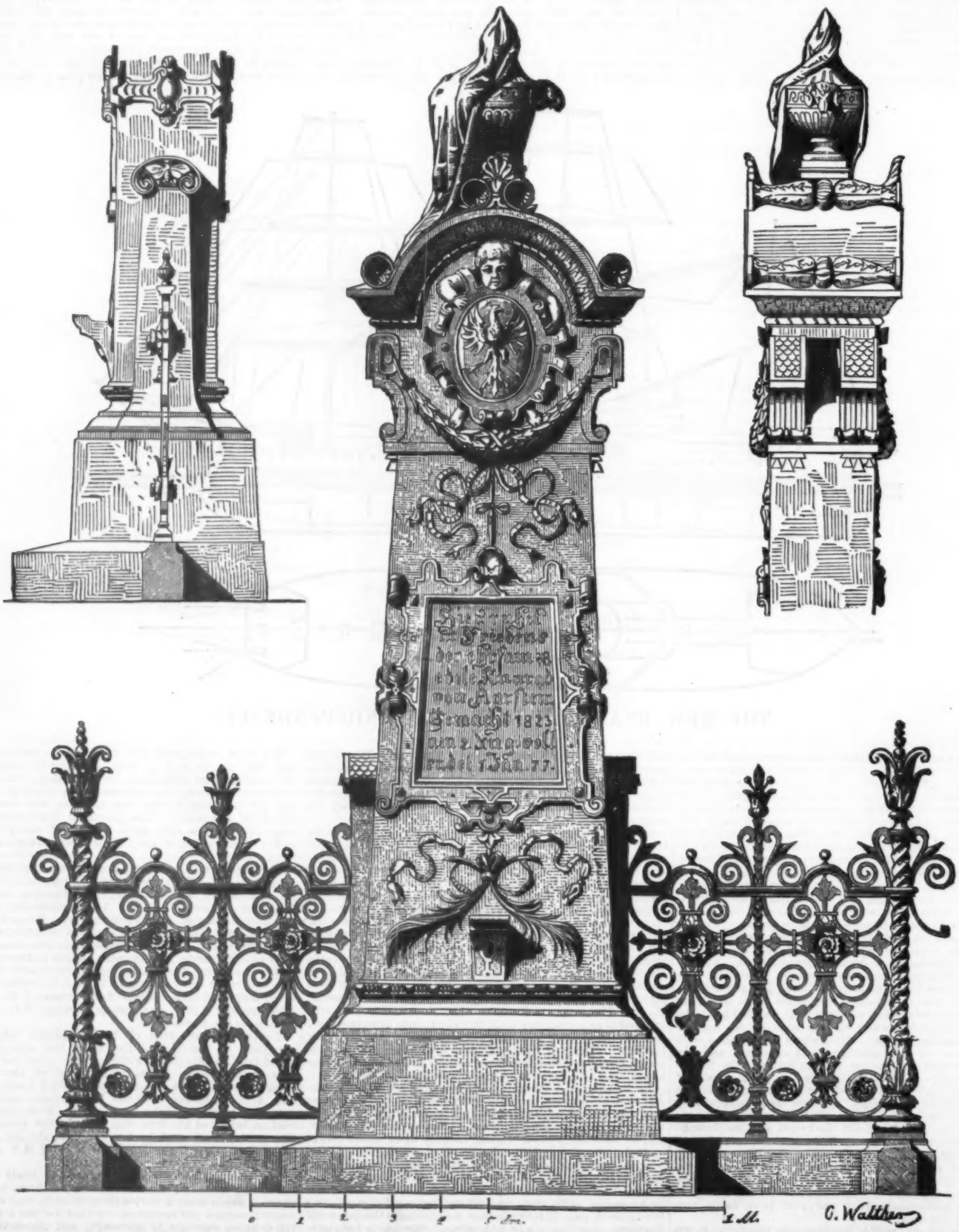
LECTURE IV.

THE boilers may be either stationary or rotary, deep or shallow, cast or malleable, of capacity measurable by cwts. or by tons, high pressure or low pressure, so diverse are the arrangements in practice in all of these particulars. For esparto a stationary boiler is always to be preferred, while, in the case of rags, there is some evidence to show that a good rotary does yield results which compare favorably with even the best stationary. Of the many forms of stationary boilers, patented and unpatented, I prefer what is known as the "vomiter," which for all ordinary purposes may be made of cast iron; but, if intended for very high pressure, is usually made of malleable plates like a steam boiler. A convenient size is nine feet six inches wide by five feet deep, and capable of boiling two tons of esparto grass. It is fitted with a perforated false bottom, with as little space below as possible. In the center of the boiler is placed a rather wide vertical tube open at both ends, the upper end being enlarged like an inverted bell, and covered at a distance of a few inches by a plate, or "bonnet," as it is called. At the bottom of this wide tube is the orifice of the steam-pipe, which usually discharges upward, but it is sometimes carried down through the cover of the boiler, and made to discharge at a distance of an inch or two from the bottom. When the boiler is charged with its complement of rags, or esparto, soda, and water, and the man-lid closed, the steam discharged at the foot of the wide tube rushes upward, carrying the soda liquor with it, and the liquor striking with some violence upon the underside of the "bonnet" discharges umbrella-like all over the surface of the raw material. This action continuing speedily empties the space beneath the false bottom, thereby forming a partial vacuum and inducing a powerful downward current through the material in process of being boiled. No sooner does the lye get below the false bottom again than it is sucked up and discharged again over the top. Such is the general action of this boiler, the principle involved being the same as that of the ordinary blower or injector, which lifts water from a well or forces it into a steam boiler under pressure. In filling such a boiler with, say, esparto, care must be taken to get as large a quantity in as possible, and this can be best accomplished by setting the "vomiter" to work after as much has been got in as conveniently can. The lid may or may not be closed, and after a time it will be found that the grass has been reduced in bulk considerably, so that a further quantity may be added. After a little time, and a repetition of the same process as before, there will be room for another supply, and so on until the full complement has been got in.

Patent covers of one description and another have been devised for the purpose of putting pressure on the grass to reduce its bulk in the boiler. I do not think the object a good one; the grass, while in the process of boiling, should not be squeezed together further than by its own weight, for, if subjected to additional pressure, some portions are sure to get so closely compact that it is with difficulty the soda can get through them, and the result is want of uniformity in the product.

In charging the boiler the soda is put in first, and dissolved in the water, which is added before the grass is introduced, this being a much more satisfactory method of procedure than that which used to be pretty generally adopted, viz., putting in the soda in solid lumps on the top of the grass. Soda takes some little time to dissolve, and, doubtless, the action of the solid soda or of the highly concentrated solution draining from it would be detrimental to those portions of the charge coming under its immediate influence. The practice as to using 60 or 70 per cent. caustic soda varies; one paper-maker tells us he cannot boil his grass soft with 60, and is obliged to use 70; another laughs at such an idea, and boils well with as many pounds of 60 as his neighbor uses of 70. Now, I believe that no one need use 70 per cent. for boiling either esparto or straw; it is proportionately more expensive, and undoubtedly points to a screw being loose somewhere when it is found that 60 per

* A recent lecture delivered before the Society of Arts, London. Lecture I., Scientific American Supplement, No. 100. Lecture II., Supplement, No. 110. Lecture III., Supplement, No. 116.



MONUMENT DESIGNED BY PROFESSOR WALTHER, NUREMBERG. *From The Workshop.*

cent. soda cannot do the work. Again, some people say they can boil Oran or African grass, which is coarser than Spanish and requires more soda, with 15½ lbs. of 60 per cent. caustic, while others cannot boil Spanish with less than 17 lbs. per cwt. No doubt the pressure under which the boilers are worked has something to do with this diversity of opinion and experience; no doubt also many makers consider grass well boiled which others would consider hard. We believe that very much depends upon the amount of solution per cwt. which one maker can manage to work with as compared with another. The stronger the solution the better the work will be done, as there is always an excess of soda used; if it is kept well concentrated it will do its work well, whereas, if it is much diluted, it will as certainly do its work indifferently. This question of the strength of the soda solution has also a powerful bearing upon the question of time of boiling, and is one of a series of circumstances which determine whether one or two charges can be got out of a boiler per twenty-four hours. In practice we have both extremes; and it is quite obvious that he who can take two charges out of his boilers in twenty-four hours can do with one-half of the plant that another, taking only one charge in the same time, must require.

The boiling having been completed, the spent soda lye is run off, and, for the sake of the profit to be made, as well as with a view to the conservation of the purity of rivers, evaporated. With the evaporation process we shall have more to do by and by. Meantime we must consider the cooling of the charge. This is usually done by simply filling up the boilers with cold water, and allowing the whole to stand quiescent for a few hours before running it off. When the "coolings," as they are sometimes called, are not permitted to be run into the stream, they are used for causticizing the recovered soda, or for dissolving the fresh caustic soda and refurnishing the boilers. Most of the millowners in Scotland have to do this, and in some cases still further pressure is put upon them. I have recently proposed a system of treating esparto, which I have found to give entirely satisfactory results alike to the paper-maker and riparian proprietor.

The actual working of the process is as follows: The "boilings," or spent soda liquor, having been drained off, the boilers are filled up with the "coolings" of previous batches, and steam turned on until the whole reaches the boiling point. It is then shut off, and quiescence maintained for four hours; one-half of the "second boilings" is then run off; the other half is kept in the boiler for two hours longer and then run off too. The liquid thus drained off in two portions is used for causticizing the soda recovered from the "boilings," and goes back to the boilers as fresh lye. The boilers are finally filled up with clean cold water and allowed to stand for four hours, when one-half is drained off and the remainder or second half is allowed to stand other two hours, when it too is drained off as before. As already indicated, the "coolings" thus run off are used for the "second boilings" of the succeeding batch. The process is based upon well-ascertained principles, and the results are satisfactory. During the periods of quiescence referred to the heavy black liquid in the stems of the grass is displaced, partly by endosmotic action and partly by gravitation, by the heavier surrounding fluid. The heavy displaced liquor sinks to the lower part of the boiler, so that when it is run off the lighter and purer liquor from above gets down to the grass below, which still retains much impurity, but this is largely displaced during the succeeding two hours' rest.

About one-third more boiler power is required, but wherever there is a serious river question or a desire for improved results, both in percentage, out-turn, and quality, the additional plant required cannot be considered a serious matter. Of course, where there is no river difficulty the simplest treatment, with a view to economical results, would be to evaporate the "boilings," and bathe the grass with clean water as often and as long as possible, running the bathings to waste each time.

Revolving boilers are not suited for esparto. This class of raw material suffers from being knocked about while in process of being boiled, as it gets broken up in such a way that the wet picking is seriously interfered with. Rags do not suffer in the same way; some portion, it is true, get rolled up into little balls, but notwithstanding this they seem to take well to the rotating process. A considerable share of the work done in the boiling of rags is the extraction of mechanical dirt from the interstices of the fabric, and the motion of the rotary seems to help to wash that out.

Revolving, like stationary, boilers are manifold in form as well as in detail; some are spherical, while others are cylindrical, and the axis of the latter again may be either horizontal or diagonal. The proportion of caustic soda used with rags varies according to their quality and purity, ranging from one or two to ten o. twelve pounds per cwt. The boiled rags or esparto, as the case may be, are drawn or emptied from the boiler after the cooling has been properly effected. The boxes into which the boiled materials are put generally hold two cwts., and are placed on wheels for convenience of transit. Before going to the washing and breaking engine the picking process is repeated, the boiling having brought to view many impurities which escaped the eye in the previous examination, and it is now the duty of the pickers to remove these, so that the pulp about to be produced may, as far as possible, be uncontaminated with hard or unbleachable particles.

Wood pulp boilers, and, indeed, the whole wood pulp process, have undergone a very satisfactory development in recent years. One of the most satisfactory of the many patented processes is that known as "Sinclair's," and, as I am familiar with the details of this system, and satisfied with the thoroughness of the work done by it, I shall describe it as representing an almost perfect system. Mr. Sinclair's patents apply to the wood boiler, and to the steam generator connected therewith. The operation of pulping, however, begins with the preparation of the timber on the saw bench, the work of the saw being to put the rough material into shape for the slicing or cutting machine. This machine slices the wood diagonally with the grain, thus facilitating the bruising or disintegrating process which follows. The wood is raised by an elevator to the hopper of a bark-mill, from which, after being bruised, it discharges into the pit of another elevator which lifts it to the flat above, where it is on a level with the mouth of the boiler. The boilers, which are about 4 ft. diameter and 18 or 20 ft. deep, and of great strength, are charged with 25 cwts. of the wood thus prepared. Along with a due proportion of water, just sufficient to cover the wood, but no more, caustic soda, in the proportion of 26 to 28 lbs. per cwt., is introduced. Before the steam is turned on the wood pulp boiler at all it is got up in a patent generator to something like 300 lbs. pressure. When the valve between the generator and the boiler is open, the pressure in the former rapidly falls to about 200 lbs.; in about two hours the soda liquor and wood have attained a corresponding temperature—about 380° F.—which is maintained for three hours more, when the valve is closed, and the pressure in the boiler reduced to about 100 lbs. by opening an escape valve at the top. The steam so escaping is utilized in heating the water used in the hydro-extractors to be presently referred to. When the desired reduction in pressure in the boilers has taken place the escape valve is closed and the discharge valve opened, when the remaining pressure forces the whole contents of the boiler into an adjoining cistern, which is fitted with an agitator. From this the stuff is delivered in successive batches through a sieve into centrifugal machines, or hydro-extractors, when the lye is first expelled, after which hot water is introduced, so as to wash the pulped wood quite clean. The product is very beautiful, the resin and other extractive matters being now thoroughly removed, and the separation of the fibers almost completely effected. The steam generator to which we have alluded is specially constructed for carrying very high pressures, and is, contrary to the opinion of timid or superficial observers, perfectly safe. An examination of every part of it while in process of manufacture has convinced me that every possible source of danger has been carefully guarded against in the most ingenious and trustworthy manner.

Besides the method of treating wood which I have just described, many other processes, both chemical and mechanical, have been proposed. I have myself made a very extensive series of experiments with the view of discovering some cheaper method, but the same practical difficulties have interposed themselves in the way as have rendered abortive the labors of others in the same direction. Several chemical agents completely and easily effect the desired object of removing the intercellular matters, leaving the cellulose pure, but they are either too expensive, too dangerous, or too difficult to recover. This latter objection is now a serious one, as the manufacturer can scarcely hope to be allowed to run such powerful chemical agents as I refer to either into sewers or streams. The mechanical operation of grinding or rubbing down raw wood into a powder is carried on extensively in America, and also, though on a smaller scale, in other wood-growing countries, and a portion of the product reaches the British paper-maker. Thus wood powder can scarcely be dignified by the name "fiber," although care is taken to apply the friction along the axis of the wood and so brush off the layers, and thereby give the product as fibrous an appearance as possible. The product of the grinding process contains all the lignine, resin, and other matters natural to the wood used; it has little or no felting power, and can only be viewed as a species of loading.

PETROLEUM OIL GAS FOR LIGHTING PASSENGER CARS.

WE have already called attention to the fact that the Philadelphia and Reading Railroad has been very successful in substituting petroleum gas for coal gas in the lighting of passenger cars, and also the extensive shops, depot, and offices of the road, at Reading, Pa. Works for the making of this gas were constructed by the company in 1874, and although their cost was much greater then than it would be now, the records show that in a little more than two years a saving was effected equal to the entire outlay. The means for using the petroleum gas on passenger cars are the same as are made use of on the Pennsylvania Railroad for coal gas, but with some decided advantages over the latter. The supply of petroleum gas in a cylinder or receiver attached to a car will last five times as long as the same quantity of coal gas, giving the same light, thus enabling a car to carry without inconvenience enough to last several nights, just as readily as it could carry a single night's supply of coal gas. Aside from the superiority of the light as compared with that of coal gas or candles, a railroad company, by manufacturing its own gas, deprives the gas companies of an extensive and very profitable line of customers; and furthermore, the compression of coal gas into receivers at a high pressure before using it injures the gas very much, while the same compression is found to injure the oil gas very little.

This system of lighting railway cars was introduced some three or four years ago in Europe by Professor Pintsch, an eminent gas engineer and manufacturer, of Berlin, and some experiments were made with it in 1874 on the London and Northwestern Railway, since which time it has been growing in favor both on the Continent and in England. A recent number of *Herapath's Journal* says that the Great Eastern Railway Company has just completed oil gas works for supplying their line, and that 238 carriages are being fitted up with the new lighting apparatus. The works have a capacity for lighting a rolling stock of 1,500 carriages. The cost of the light is less than one-eighth of a penny per hour per burner, and the saving of labor enormous. As a proof of this, says the *Journal*, Mr. Pintsch's firm offer to find fittings, gas works, labor, and material, and to supply the light for a less charge than the cost of the present oil lamps. The gas is said not to deteriorate by keeping, but will burn just as well six months after its manufacture as on the first day of its use; nor is the light affected by the speed of the train or the state of the weather.

Much more is said by the writer in *Herapath* in praise of the light and the economy of its use; but making due allowance for possible exaggeration, the subject is certainly deserving of the serious attention of our own railroad managers. The advantages of well and cheaply lighted cars ought to be more fully appreciated in England than here, on account of the numerous trains, opaque atmosphere, and short winter days. Although comparatively less lighting is necessary in our climate and latitude, it is equally desirable that what we do have should be a great deal better than is now provided upon the great majority of passenger cars. After making proper allowance for exceptional cases, where the lighting is considerably better than the average, it is a matter of almost universal complaint that our cars need more illumination, especially local trains in the vicinity of large cities. The lights upon these are, as a rule, dim and diffused, and barely sufficient to enable the best of eyes to read the evening papers.—*National Car-Builder.*

OPTICAL PROPERTIES OF GLASS.

AT a recent meeting of the Edinburgh Photographic Society a demonstration was given, by means of the oxyhydrogen polariscope and other apparatus, of "some properties of glass," by Mr. W. Gilmour. The experiments were thoroughly successful, very beautiful, and afforded much pleasure to the members.

After an apology for not having something more immediately bearing upon photography to bring before the meeting, Mr. Gilmour stated that he intended taking them to a closely allied subject, and would make all his remarks "On some Properties of Glass" corollate as much as possible round lenses. A lens in its simplest definition, it was explained, was a glass so prepared that the rays of light passing through it were refracted. All simple lenses, however, did not more than refract the light passing through them, for they also dispersed it, owing to the unequal refrangibility of the different rays which formed ordinary white light. This property of refraction and dispersion was shown by means of a ray of light from an oxyhydrogen jet; the amount of refraction being determined by the distance the ray of light was bent out of its straight course, while the dispersion was determined from the length of the band of color produced by the accompanying decomposition of light. Newton, who first discovered the compound nature of light, held that refraction and dispersion were both reciprocal and proportional; that is to say, there could not be refraction without dispersion, nor could there be dispersion without color; and further, that the dispersion was in a corresponding ratio to the refraction. The apparent truth of this theory was shown by the refraction and dispersion produced by transmitting light through different media, such as glass, water, bisulphide of carbon, etc., by means of which it was shown that where a ray of light was much refracted the dispersion was correspondingly great, and *vice versa*. Nearly half a century later, however, another philosopher discovered that by combining substances of unequal refractive and dispersive powers the dispersion might be got quit of, leaving still a considerable amount of refraction; and referring to the very interesting donation which had recently been given to the society in the shape of a lens achromatized by means of water, the speaker stated that he had referred to this principle of achromatism for the purpose of showing the achromatic action of the water. This was done by a very interesting and beautiful experiment, in which the decomposing action of the lens was first shown, then the achromatic action of the water, and lastly the residue of refraction after the lens was properly achromatized. Referring next to the refractive action of all transparent substances, it was stated that they might all be classified into two divisions, namely, those that were single refractors and those that were double refractors. The single refractors required no explanation, but the double refractors were illustrated by passing the light through a crystal of sulphate of lime, and double refraction itself explained and illustrated in various ways. This was done for the purpose of explaining the remarkable property of glass, whereby it might be resolved either into the division of single or double refracting substances. A perfectly homogeneous plate of glass, for example, was shown by several experiments to be capable of being converted into a double refracting plate, this being done by pressure, by heat, etc. The process of annealing glass was next referred to, and illustrated by several very interesting and beautiful experiments, and the whole of the remarks on double refraction were briefly summarized in their practical bearing on and application to lenses, as stated at the commencement. Not the least interesting part, however, of the communication, though not bearing on the practical aspect of the subject, was the exhibition of plates of an unannealed glass in which the double refracting structure closely resembled the double refracting structure of natural crystallizations.

THE BITUMEN OF JUDEA PROCESS.

HERR HUSNIK, finding that the bitumen of Judea is too slowly impressed by light, has sought to increase its sensitiveness by the admixture of various substances, so that the bitumen might be made use of in heliographic printing. The *Monatsblatter* mentions the method he employs, which consists in mixing with the bitumen some alkaline bichromate. To accomplish the matter perfectly, however, he requires a solvent which will at once dissolve the resin and the bichromate.

Solutions of borax, the caustic alkalies and their carbonates, soaps, and liquid ammonia, which dissolve the resin, have all answered in some degree to effect their purpose, but of all he specially recommends liquid ammonia. He dissolves ordinary resin, shellac, gum dammar, or any other resin, adds to them a little alcohol, and to this solution, containing from three to four per cent. of resin, he adds some bichromate of ammonia, and thus obtains a mixture which, poured upon a metal plate, dried, and printed, yields a film in which the parts which have been subjected to the action of light are completely insoluble in such liquids as usually dissolve the resins, such as caustic alkalies, alcohol, essence of turpentine, benzole, etc. Those parts of the film which have not been acted upon by light remain, on the other hand, perfectly soluble in the alkalies and essences.

THE SOCIETY OF TELEGRAPH ENGINEERS.

WHEN a society which numbered 110 members at the date of its first public meeting can, after an existence of only six years, count 1,000 names upon its books, it has at least justified its existence, and those who have taken the chief part in calling it into being and guiding its course may fairly consider that the numbers who have sought association with them prove that their proceedings have been, at any rate, not injudicious. It was, therefore, with good reason that Dr. C. W. Siemens began his address to the Society of Telegraph Engineers on the occasion of his re-election to the office of President by congratulating the society on the progress made by it since he addressed it in the capacity of its first President on February 28, 1872.

In these congratulations we heartily join, and we think that no one will question the wisdom of the society in calling back to the Presidentship a man who did so much in the early days of its career to prepare the way for the success since realized.

The claim of the Society of Telegraph Engineers to rank as a scientific institution cannot, however, be founded upon the mere number of its members, nor even on the scientific eminence of some of the names to be found in the list. Its scientific position must, of course, be judged of by considering not how many or who its members are, but what they do in their associated capacity for the advancement of science. Ample materials for forming such an estimate as this are afforded by the six substantial volumes already published of the *Journal* of the Society of Telegraph Engineers. These volumes contain the papers communicated to the society and reports of discussions at the meetings, and in addition a considerable number of reprints or abstracts of papers published elsewhere bearing on the objects pursued by the society. As might be expected in the case of a society founded primarily to promote the advancement, not of abstract science, but of a branch of industrial enterprise, papers of a so-called "practical" kind are the most numerous, and, if we may judge from the reported discussions, papers of this class are those which call forth the most

general interest at the society's meetings. But even among such papers, embodying as they usually do the results of careful observation and long experience on the matters of which they treat, there are few from which the student of physics may not gather some hint of value. There are, however, a considerable number of papers of which the scientific bearing is more direct. These are papers which, dealing with questions arising primarily out of the practice of the telegraph engineer, treat the problems discussed from the point of view afforded by the general scientific principles applicable to them, or which contain results of no less scientific than practical value. Among papers of this class, one by Mr. Hockin (vol. v., pp. 432–459), on "The Magnitude of Signals received through a Submarine Cable with various Connections at each end, and the best Resistance for the Recording Instrument," is specially deserving of mention. It contains a very masterly treatment of what is in reality a purely scientific problem, though one which has very direct practical importance. And here we may digress for a little in order to point out that this paper of Mr. Hockin's affords an instructive illustration of the mutual beneficial interaction between 'theory" and "practice," of which the whole history of the electric telegraph is full. The telegraph is in a fuller degree than most practical inventions the direct outcome of scientific investigation, but when, in the progress of telegraphic enterprise, the project arose of laying long submarine lines, it was found that, though the general nature of the electrical difficulties to be encountered was known, yet the scientific knowledge of the time was not sufficient to indicate clearly the way in which they were to be overcome, and from the nature of the case but little help was forthcoming from empirical experience. The matter was in this state when Sir William Thomson took up the question of the transmission of signals through submarine telegraph cables, and showed how the practical message-carrying power of an insulated conductor laid under water is connected with the dimensions and certain definite electrical qualities of the conductor and its insulating coating. The conclusions which he arrived at mathematically as long ago as 1855 have since remained the foundation of all successful practice in the manufacture of telegraph cables. Sir W. Thomson, however, took account only of the properties of the cable itself, whereas in the actual working of submarine telegraphy very much depends upon the proper selection and arrangement and adaptation to each particular cable of the sending and receiving apparatus employed at the two ends; and what Mr. Hockin has now done is to give a general theory which takes account of the electrical properties of the instruments as well as of the cable. Returning to the *Journal* of the Society of Telegraph Engineers, we may mention a short paper by Mr. Sabine on "The Capacity of Accumulators Variously Combined," one by Sir William Thomson on "The Comparison of Electrostatic Capacities," and a note by Prof. Maxwell on "The Theory of Lightning Conductors," among the original articles, as well as Messrs. Longridge and Brooks' paper on "The Submergence of Telegraph Cables," and Mr. Schwendler's on "The Theory of Duplex Telegraphy," among the reprints, as examples which afford further proof that the society, established for practical objects, is not blind to the aid to be derived in the pursuit of those objects from the study of scientific principles. And although we do not suppose that all the 1,000 members study such papers as we have referred to with great eagerness, yet the mere fact of their circulation must do something to convince the most arrogantly "practical" man among them that ignorance is not in all respects a ground for thankfulness.

So far this flourishing society has professedly occupied itself only with telegraphy, but there are not wanting signs, either in the *Journal* or in Dr. Siemens' address, of the difficulty of separating telegraphy from other departments of what may be called applied electricity. Thus, more than one paper has been read to the society upon the application of electricity to firing mines and torpedoes, an operation which, when successfully performed, generally results in causing the persons affected to dispense permanently with telegraphic communication, and Dr. Siemens devotes nearly a quarter of his address to discussing the application of electricity for illuminating purposes, to the transmission of motive power, and in metallurgic processes. Recent improvements in the means of obtaining powerful electric currents seem to open up a prospect of such applications as those just mentioned assuming in the near future greater practical importance than they have hitherto possessed, and it does not seem unlikely that, whether or not they think fit to assume the wider designation, the Society of Telegraph Engineers will have become a Society of Electrical Engineers.—G. C. F., *in Nature.*

ELECTRICAL AND TELEPHONIC EXPERIMENTS.

PROFESSOR ALEXANDER GRAHAM BELL, inventor of Bell's telephone, in a recent lecture in England mentioned the following: It was always my belief that a certain ratio would be found between the several parts of a telephone, and that the size of the instrument was immaterial; but Professor Peirce was the first to demonstrate the extreme smallness of the magnets which might be employed. And here, in order to show the parallel lines in which we were working, I may mention the fact that two or three days after I had constructed a telephone of the portable form containing the magnet inside the handle, Dr. Channing was kind enough to send me a pair of telephones of a similar pattern, which had been invented by the Providence experimenters. The convenient form of mouthpiece now adopted by me was invented solely by my friend Professor Peirce. I must also express my obligations to my friend and associate, Mr. Thomas A. Watson, of Salem, Massachusetts, who has for two years past given me his personal assistance in carrying on my researches.

In pursuing my investigations I have ever had one end in view—the practical improvement of electric telegraphy; but I have come across many facts which, while having no direct bearing upon the subject of telegraphy, may yet possess an interest for you.

For instance, I have found that a musical tone proceeds from a piece of plumbago or retort carbon when an intermittent current of electricity is passed through it, and I have observed the most curious audible effects produced by the passage of reversed intermittent currents through the human body. A rheotome was placed in circuit with the primary wires of an induction coil, and the fine wires were connected with two strips of brass. One of these strips was held closely against the ear, and a loud sound proceeded from it whenever the other slip was touched with the other hand. The strips of brass were next held one in each hand. The induced currents occasioned a muscular tremor in the fingers. Upon placing my forefinger to my ear a loud crackling noise was audible, seemingly proceeding from the finger itself. A friend who was present placed my finger to his ear, but heard nothing. I requested him to hold the strips himself. He was then distinctly conscious of a noise (which I was unable to perceive) proceeding from his finger. In this case a portion of the induced currents passed through the head of the observer when he placed his ear against his own finger: and it is possible that the sound was occasioned by a vibration of the surfaces of the ear and finger in contact.

When two persons receive a shock from a Ruhmkorff's coil by clasping hands, each taking hold of one wire of the coil with the free hand, a sound proceeds from the clasped hands. The effect is not produced when the hands are moist. When either of the two touches the body of the other a loud sound comes from the parts in contact. When the arm of one is placed against the arm of the other, the noise produced can be heard at a distance of several feet. In all these cases a slight shock is experienced so long as the contact is preserved. The introduction of a piece of paper between the parts in contact does not materially interfere with the production of the sounds, but the unpleasant effects of the shock are avoided.

When an intermittent current from a Ruhmkorff's coil is passed through the arms a musical note can be perceived when the ear is closely applied to the arm of the person experimented upon. The sound seems to proceed from the muscles of the fore-arm and from the biceps muscle. Mr. Elisha Gray, of Chicago, has also produced audible effects by the passage of electricity through the human body.

An extremely loud musical note is occasioned by the spark of a Ruhmkorff's coil when the primary circuit is made and broken with sufficient rapidity; when two rheotomes of different pitch are caused simultaneously to open and close the primary circuit, a double tone proceeds from the spark.

A curious discovery, which may be of interest to you, has been made by Professor Blake. He constructed a telephone in which a rod of soft iron, about six feet in length, was used instead of a permanent magnet. A friend sang a continuous musical tone into the mouthpiece of a telephone, which was connected with the soft iron instrument alluded to above. It was found that the loudness of the sound produced in this telephone varied with the direction in which the iron rod was held, and that the maximum effect was produced when the rod was in the position of the dipping-needle. This curious discovery of Professor Blake has been verified by myself.

When a telephone is placed in circuit with a telegraph line, the telephone is found seemingly to emit sounds on its own account. The most extraordinary noises are often produced, the causes of which are at present very obscure. One class of sounds is produced by the inductive influence of neighboring wires and by leakage from them, the signals of the Morse alphabet passing over neighboring wires being audible in the telephone, and another class can be traced to earth currents upon the wire, a curious modification of this sound revealing the presence of defective joints in the wire.

Professor Blake informs me that he has been able to use the railroad track for conversational purposes in place of a telegraph wire, and he further states that when only one telephone was connected with the track the sounds of Morse operating were distinctly audible in the telephone, although the nearest telegraph wires were at least forty feet distant.

Professor Peirce has observed the most curious sounds produced from a telephone in connection with a telegraph wire during the aurora borealis; and I have just heard of a curious phenomenon lately observed by Dr. Channing. In the city of Providence, Rhode Island, there is an overhouse wire about one mile in extent with a telephone at either end. On one occasion the sound of music and singing was faintly audible in one of the telephones. It seemed as if some one were practicing vocal music with a piano-forte accompaniment. The natural supposition was that experiments were being made with the telephone at the other end of the circuit, but upon inquiry this proved not to have been the case. Attention having thus been directed to the phenomenon, a watch was kept upon the instruments, and upon a subsequent occasion the same fact was observed at both ends of the line by Dr. Channing and his friends. It was proved that the sounds continued for about two hours, and usually commenced about the same time. A searching examination of the line disclosed nothing abnormal in its condition, and I am unable to give you any explanation of this curious phenomenon. Dr. Channing has, however, addressed a letter upon the subject to the editor of one of the Providence papers, giving the names of such songs as were recognized, with full details of the observations, in the hope that publicity may lead to the discovery of the performer, and thus afford a solution of the mystery.

My friend Mr. Frederick A. Gower communicated to me a curious observation made by him regarding the slight earth connection required to establish a circuit for the telephone, and together we carried on a series of experiments with rather startling results. We took a couple of telephones and an insulated wire about 100 yards in length into a garden, and were enabled to carry on conversation with the greatest ease when we held in our hands what should have been the earth wire, so that the connection with the ground was formed at either end through our bodies, our feet being clothed with cotton socks and leather boots. The day was fine, and the grass upon which we stood was seemingly perfectly dry. Upon standing upon a gravel walk the vocal sounds, though much diminished, were still perfectly intelligible, and the same result occurred when standing upon a brick wall one foot in height, but no sound was audible when one of us stood upon a block of freestone.

One experiment which we made is so very interesting that I must speak of it in detail. Mr. Gower made earth connection at his end of the line by standing upon a grass plot, while at the other end of the line I stood upon a wooden board. I requested Mr. Gower to sing a continuous musical note, and to my surprise the sound was very distinctly audible from the telephone in my hand. Upon examining my feet I discovered that a single blade of grass was bent over the edge of the board, and that my foot touched it. The removal of this blade of grass was followed by the cessation of the sound from the telephone, and I found that the moment I touched with the toe of my boot a blade of grass or the petal of a daisy the sound was again audible.

The question will naturally arise, Through what length of wire can the telephone be used? In reply to this I may say that the maximum amount of resistance through which the undulatory current will pass, and yet retain sufficient force to produce an audible sound at the distant end, has yet to be determined; no difficulty has, however, been experienced in laboratory experiments in conversing through a resistance of 60,000 ohms, which has been the maximum at my disposal. On one occasion, not having a rheostat at hand, I may mention having passed the current through the bodies of sixteen persons, who stood hand in hand. The longest length of real telegraph line through which I have attempted to converse has been about 250 miles. On this occasion no difficulty was experienced so long as parallel lines were not in operation. Sunday was chosen as the day on which it was probable other circuits would be at rest. Conversation was carried on between myself, in New York, and Mr. Thomas A. Watson, in Boston, until the opening of business upon the other wires. When this happened the vocal sounds were very much diminished, but still audible. It seemed, indeed, like talking through a storm. Conversation, though possible, could be carried on with difficulty, owing to the distracting nature of the interfering currents.

I am informed by my friend Mr. Preece that conversation has been successfully carried on through a submarine cable, sixty miles in length, extending from Dartmouth to the Island of Guernsey, by means of hand telephones.

NEW FORM OF TELEPHONE.

HAVING had the pleasure of listening to Mr. Preece and Prof. Graham Bell explaining that most wonderful invention, the telephone, at the late meeting of the British Association in Plymouth, I endeavored to obtain the instrument for my own use, and was ultimately successful.

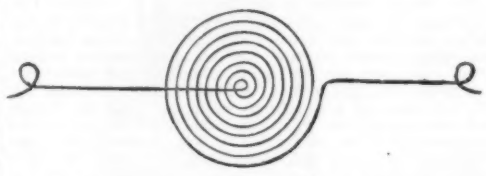
It soon struck me that if the disk or diaphragm whose vibration causes the induced current in the coil of copper wire must be a magnetic substance, and not simply a conductor, then if I could succeed in getting an electro-magnet to vibrate in a similar manner it might be possible to get as powerful a sound.

With this object in view a coil of insulated copper wire was fastened to a card, as shown in Fig. 1.

The wire used was No. 28 cotton-covered, and it was sewed to the card with thread.

The iron disk was taken out of one of the telephones, and the coil-diaphragm put in its place, through which a current

FIG. 1.



was passed from a single Bunsen cell. On making connection with the other telephone, talking, singing, and whistling were heard distinctly at both.

Various coils have since been tried both with thicker and also thinner wire, but as yet the results have not been as good as when the iron disk is used.

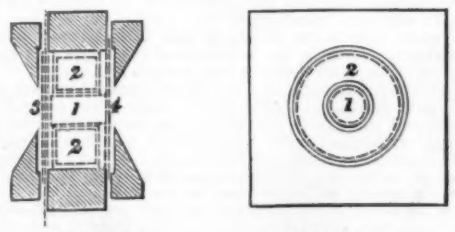
When two such coils are used, one superposed on the other, the loudness of the sound transmitted is increased to some extent. The same result is produced by adding another Bunsen cell. With a Daniell's cell the sound is very feeble. When a coil is placed in each telephone the result is rather unsatisfactory as yet.

It has also been noticed that a simple conductor, as a coil of copper wire, also transmits sound, but very faintly.

A small apparatus (Fig. 2) has been made to show the effects above described. A piece of wood about three inches square and about one inch thick has a hole bored through it about two inches in diameter. A reel (2) containing about 250 yards of silk-covered copper wire is placed in the hole with a piece of soft iron about half an inch in diameter as axis (1).

A coil-diaphragm (3) is placed across one end of the hole at a very short distance from the soft iron core, and is covered by a mouthpiece. Across the other end of the hole

FIG. 2.



1. Iron core.
2. Coil of wire.
3. Coil diaphragm.
4. Iron disk.

at a similar distance from the core is placed a thin iron disk (4), which is also covered by a mouthpiece. On a current being passed through the coil-diaphragm this apparatus acts as a telephone, and messages can be sent from either side of it.

The iron disk and core may be removed, and the coil-diaphragm alone acts in an exactly similar manner.

The above are the results of some experiments which have occupied my spare time lately, and not having seen anything similar published I forward them to you, as they are rather interesting. The whole of the experiments have been conducted with the aid of my friend, Mr. G. B. Nicoll, who has also made many important suggestions.—JAMES M. ROMANIS, in *Nature.*

IMPROVED TELEGRAPH INKER.

SINCE the invention of the inking disk by Mr. Thomas John, in 1856, various arrangements have been devised for furnishing the marker of Morse apparatus with the ink necessary for the impression of signals. In the system adopted by the Austrian engineer, and in the more recent one of Messrs. Siemens & Halske, the disk has a double movement of oscillation and rotation in a reservoir filled with ink; but the arrangement most generally in use since 1857 is that of Messrs. Baudoin & Digney, in which the marking disk is rubbed tangentially by a roller soaked with an oily ink. * * *

The practical value of any inking method is gauged by the neatness of the impressed signals, the length of the interval between two successive renewals of the ink, and the amount of care required to keep the apparatus in good

working order; on these depends the speed at which messages can be taken off.

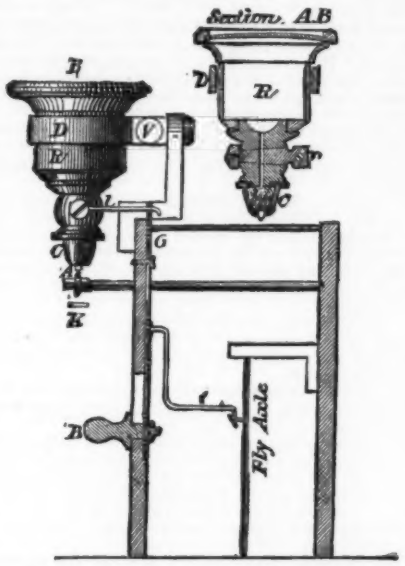
In this respect the pad (*tampon*) presents faults which the Messrs. Digney have sought to obviate by giving to it a to-and-fro movement, and in compelling it to rotate under the action of light supplementary parts.

More recently the same inventors have improved the absorption of the pad by placing above the inking disk an oscillating reservoir, capped with a compressor, and held below by a throat-piece or tongs.

This arrangement has just been modified by M. Devos, mechanician to the Belgian telegraphs. * * *

The inker of M. Devos is composed of three parts: A reservoir, R, a conduit which can be opened and closed by the stop-cock, *r*, and a tank, *c*, the bottom of which is pierced with an opening, and in which is placed some bibulous material, wool, sponge, or cotton preferably, to perform the office of the ordinary roller.

This inker is adjusted over the inking disk in a collar, D, which can be tightened by the screw, V, and is supported by



IMPROVED TELEGRAPH INKER.

an angle-piece fixed to the case of the Morse instrument.

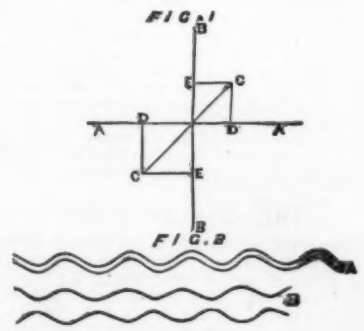
The ink from the reservoir is only admitted to the tank while the paper is traveling; the same motion which releases the clockwork opens the stop-cock, *r*, while the stoppage of the fly closes it.

To this end the rod, *l*, rests in a notch in the slide, G, movable vertically, and provided with a knob, B. From G there is a bent lever, *t*, which, when the clockwork is closed, is caught by the fly. On raising the knob, B, the train is released and the stop-cock, *r*, is opened, and *vice versa*. When the supply of ink becomes deficient, it is only necessary to press the dome-shaped spring at the head of the reservoir, R. This spring can be caused to resume its shape by placing in the upper part of the ink bottle a ring or perforated plate to limit the depression.

Morse instruments, fitted with M. Devos' inker, have been in use for four months at some of the principal Belgian telegraph offices. The staff are unanimous in their opinion of the superiority of this arrangement over the ink-roller. On an average one charge of ink is sufficient for the reception of 1,600 messages, including acknowledgments and repetitions.—*Journal Télégraphique.*

COLOR IN POLARIZED LIGHT.

ICELAND spar (and, indeed, all double refracting bodies) allows a portion of the light (other than that of which the vibration is coincident with its planes of vibration) to pass by altering its plane, and thus really reduces the vibrations to two planes only. The vibrations not originally in these planes are divided exactly in accordance with the mechanical resolution of forces. Thus, if we make a figure of the two planes of the prism, A A and B B, and suppose C C to be

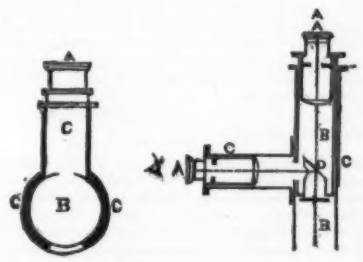


a vibration at any angle, it will be resolved into C D and C E, and so on for every possible vibration. The importance of this will be seen later on.

In order to understand the production of color with polarized light, it is first necessary we should clearly understand its production under ordinary circumstances. Light is a complex and compound phenomenon, but we can leave out of consideration some of its powers and thus simplify it a little. For our purpose it is sufficient to consider it as compounded of seven different colors. I should not like to pledge myself to the number, but that is of no consequence in my point of view. The difference of color is simply a difference of length of wave. The sensation we call violet, for instance, is produced by a shorter wave than the other colors, and what we call red by a longer wave. There are about 37,000 red waves in an inch long, and more than 64,000 of the extreme violet. The other colors have wavelengths between these extremes. Now, if any body is seen by white light incident upon it, its color is dependent on its power to quench or absorb some of these vibrations. If it appear red, it simply means that it has taken away all the more rapid vibrations, and only reflected the slower. If it appear violet, it means that it has taken away all the slower vibrations, and only reflects the quickest and shortest. Thus, in every case color is the result of some part of the beam of white light being destroyed. In like manner, if light be transmitted through any substance, such as colored glass for instance, the reason of the appearance of red or green or violet is simply that the rest of the vibrations are stopped by the glass, and only those of one wave-length can pass. If this is correct, then any substance viewed by a monochromatic light must either appear of that color or black; since if it is incapable of reflecting or transmitting, as the case may be, the red or the violet light when those colored lights are used *pure* for its illumination, it can then reflect no vibrations at all. This is exactly what does occur. But we have seen that light is wave motion only, and analogous to other wave motion. Therefore, if we have two waves traveling from the same point in the same direction with the crests of one coincident with the crests of the other, as at A, Fig. 2, then we have augmented vibration and increased intensity; but if one be half a wave-length in advance of the other, as at B, then the crest of one will conflict with the hollow of the other, and the vibration is stopped; consequently we have darkness. The ether particles, whose vibration we call light, remain at rest, because the one system of waves pulls exactly as much to the right as the other to the left. But if a beam of light be compounded of two colors only, as red and violet, of different wave-length, then if the vibration producing violet be quenched by an opposing wave, just half a violet wave-length in advance, the red being a longer wave will not be so quenched, but the result will be red light only. This will apply to any compound light, and is perhaps best illustrated by a soap bubble. When a ray of light is thrown on a soap bubble part of it is reflected from the first surface, and part refracted in the substance and reflected from the second surface. If the bubble be so thin that there is just room in its substance for half a vibration of any color, then the two beams will be one in advance of the other upon leaving the soap bubble. Thus, if the thickness allows of half a vibration of red, or one and a half, or any odd number of halves up to a certain point, then the one set will interfere with the other set, and extinguish the red; consequently, the bubble appears the color of the remainder of the beam. As the bubble becomes thin the shorter waves interfere, and the color changes toward red. This is true of any thin film of any transparent substance whatever. The color seen depends entirely, whether reflected or transmitted, upon a retardation of part of the light to the extent of half a wave-length, thus extinguishing part of the light, and consequently leaving the remainder of the complementary color required to make up white light. Consequently, whenever a retardation and consequent interference takes place, we have the production of color. In my next I shall apply these facts to explain the production of color by polarized light.—*English Mechanic.*

MICROSCOPICAL ADJUNCT.

THE original body of the microscope should have an elliptical hole about 1¼ in. longest diameter, cut on one side at about 5 ins. down from top. Exactly opposite to this fix a piece of tinted glass, D, at an angle of 45° in the end of draw tube. (I have adapted Beale's camera for this purpose.) A second body, C, should then be made of a piece of brass tube, suited to take a second eyepiece, and a little shorter than the distance from center of reflector to top of first body. This tube is to be soldered on to a sleeve, fitting steadily over first body. This is best done by filing the tube to a miter and then making a hole of the same size through the split sleeve. All is then ready for use. The instrument being inclined to a fit angle, the draw tube is slid in and turned till the second observer sees the light from the mirror clearly reflected in the neutral tint. The second body is then slid round, and the eyepiece inserted. If an object be now placed on the stage and correctly focused by the first



observer, the second obtains his focus by drawing his eyepiece either in or out, as required, the two eyepieces being then in unison. Any further focusing can be done for both by either.

There is a slight diminution of light to the supplemental body, and, unless the reflector be extremely thin, a secondary image; but these objections are of slight importance compared with the advantage a learner receives from seeing an object at the same time under the same conditions as his teacher. An earnest microscopist, too, who may be desirous of showing his treasures to friends, is spared the pain of seeing his instrument unskillfully handled, as all movements may be under his own control. The glass reflector has no effect on the direct vision, as would be the case in a double-bodied instrument with prisms. When not in use the second body is turned to front, and all irregular light shut out by the sleeve.

By using an eyepiece of lower power and longer focus in the second place the two images may be made very nearly alike so far as light and sharpness of definition go, though of different diameters. References to sketch: A A, eyepieces of equal power; B, usual single body; C, supplemental body; D, neutral tint reflector.—*English Mechanic.*

A PHYSICIAN of Sandy Hill, N. Y., says that while in this city attending lectures he and a companion lived for two months on twenty-five cents a day each. They cooked their own food, which was varied and plentiful, consisting of meat, milk, Graham bread, oatmeal, vegetables, and occasionally oysters.

HOW TO SECURE GOOD HEALTH.

AT a public lecture at Salisbury Hall, Oxford Street, recently, Dr. T. L. Nichols, of Malvern, related particulars of a "Dietetic Experiment" upon himself, which he had made with a view to solving a difficulty as to the quantity of food per diem which would best sustain health. He had always been temperate, his only excess being to be overworked. He rose between five and six, and worked well through the day, but avoided night-work. He seldom knew pain, never took medicine, and had excellent health. He usually ate twice in the twenty-four hours, at nine and five, because, for him, long rest for the stomach was better than shorter intervals. He appeared to sleep better for not eating after four o'clock. Every one should sleep upon, at least, a quiet stomach. He had carefully noted the "dry weight" of the food he had taken. Oatmeal, etc., he counted as dry weight. The weight of water forming a large portion of all food had not been reckoned, because it did not supply nutrition. Eggs and milk were perfect foods, but were largely composed of water. Milk was the most perfect food, though not the best for adults. He began on November 5, his food being chiefly bread, fruit, milk, and vegetables. During the experiment he had taken no flesh meat, wine, beer, spirits, tea, coffee, or tobacco. With regard to smoking, if it were the good thing people said it was, why not encourage their wives and daughters to smoke? Medical authorities differed as to the quantity of food that should be eaten, and it was a common belief that the more food we ate the greater would be our strength.

The first week, the lecturer stated, he lived on bread, milk, fruit, and vegetables, the total weight being 3 lbs. 9½ ozs., costing 3s. 1d., *i. e.*, a daily average of 8¾ ozs., costing 5½d.; this was slightly below his standard at 6d. a day. He felt better, and clearer, and brighter than usual. The second week he studied quality rather than cheapness, his food being Food of Health, milk and fruit. Total weight 4 lbs. 4¼ ozs., cost 3s. 8d., average per diem 9⅝ ozs., costing 6¾d., and nothing could have been better, physiologically, than the effect of that food upon him. His digestion was simply perfect, and the action of the whole system as good as it could be. He then discontinued milk as unnecessary. For the third week the total amounted to 3 lbs. 2 ozs. = 1s. 9d., giving an average of 7½ ozs. of food, costing only 3d. per day. Milk was not so cheap for food as Gloster, Dutch, and American cheese, because they had to pay for the water it contained. Doctors recommended 2 or 3 lbs. of food daily to repair the waste of the system; but he asserted that the waste of brain atoms and nerve force could not be measured. The food eaten had to be disposed of at great cost of life and strength, and he believed the wisest plan was to eat the smallest quantity that would properly support the body. The fourth week his food, being similar, weighed 3 lbs. 6 ozs., costing 1s. 2½d., giving an average of 8 ozs. = 2d. per day. He considered 8 ozs. the *minimum* and 12 ozs. the *maximum* quantity of food that should be taken per day. The total weight of his food during the four weeks was 14 lbs. 6 ozs., costing 9s. 8½d., average per week 3 lbs. 9½ ozs., per day 8½ ozs., costing per week 2s. 5d., and per day 4½d. He then added soups, puddings, eggs, etc., and the fifth week his food weighed 3 lbs. 12½ ozs., costing 3s. 4d., being at the rate of 8¾ ozs., at 5½d. per day. For the sixth week the figures were 63 ozs., at 2s. 1d., or 9 ozs., at 3½d. per day. He had taken the diet without stimulants and had experienced a constant increase of health and strength and power to work, and his weight had remained at about 12 st. 2 lbs., except that at the end of the fourth week there had been a slight decrease which had since been recovered. The experiment had been fairly made upon an average subject, and the results were satisfactory. He was convinced that they ought to give rest to the stomach, and this would cure all cases of dyspepsia. The diet question was at the root of all diseases. Pure blood could only be made from pure food. Proper attention to diet would reduce the rate of infant mortality and remove many diseases. If the drink of a nation were pure and free from stimulating qualities, and the food was also pure, the result would be pure health.

MEDICAL NOTES.

Bloodless Tracheotomy.—Every one who has been called upon to perform tracheotomy upon a young child suffering from threatening asphyxia, where the venous plexuses of the neck are engorged, and each touch of the knife may flood the wound with blood, will appreciate any method of operating by which this danger can be avoided, and tracheotomy added to the list of the bloodless operations. The attempt to accomplish this has been several times made. In 1872 M. Verneuil employed the galvanic cautery instead of the bistoury in several cases with success; but this method is evidently ill-adapted for general use, as the necessary apparatus is cumbrous, and only to be found at hospitals. More recently Mons. G. Poinsot, of Bordeaux, has used Paquelin's thermo-cautery with excellent results, and his example has been followed by other French surgeons. The skin and soft parts quite down to the trachea should be divided by successive light touches of the point of the cautery, heated to a dull red color, and when the trachea has been exposed it should be opened with the knife, and the tube inserted in the usual way. The cautery must be used lightly, or its action will be too extensive, and a thick eschar be formed; and if it be used too hot, as is well known, it loses its hemostatic power. The cautery is not suited for opening the trachea, because the radiation from its hot point introduced into the air-passage would be harmful, and there is some risk of burning its posterior wall; while in adults it is difficult to sever the firm rings with it, and particularly if they are at all ossified, and the loss of substance that an eschar necessarily involves might cause trouble from narrowing of the air-tube. On the other hand, as the use of the knife for this purpose does not cause hemorrhage, it is free from objection. In fat subjects the wound may become filled with molten fat; this is readily removed with a sponge. In addition to the bloodlessness of this mode of operating, Mons. Poinsot claims for it two other advantages —the spontaneous retraction of the edges of the wound, rendering unnecessary the aid of assistants for this purpose, and giving a funnel-shaped opening down to the trachea; and the protection of the wounded surfaces from the contagion of diphtheria. Slight secondary hemorrhage has followed this operation in several cases, but in no case has it been severe, yielding readily to simple treatment. Although the wound gapes widely at first, the resulting cicatrix contracts to a small size, and has not given rise to any unpleasant symptoms in any recorded case. This appears to be one of the most useful applications of this recent addition to the surgeon's armamentarium. It promises to change tracheotomy from an operation which is always anxious and often very trying into a safe and simple proceeding;

and we may hope that it will, in this way, add to the value of the operation by leading to its more frequent and earlier adoption in obstructive diseases of the larynx.

Cholera.—It may be doubted whether, during the past month, Egypt has not watched with greater anxiety the progress of cholera in the Hedjaz than the progress of the war in Turkey and in Asia Minor. Notwithstanding the large contingent of troops she has sent to the war in Europe, that evil is still at a distance from her, but the cholera is near at hand, and she retains a lively recollection of the ravages of the disease in 1865-66. The outbreak of the disease in Mecca would appear to have been sufficiently serious. The total mortality there from all causes from December 24, 1877, to January 12, 1878, is stated to have been 1,382, of which 785 deaths were assigned to cholera. In Jeddah the total mortality from all causes from December 29 to January 6 was 220, of which 96 deaths were reported as due to cholera. The last news from the Red Sea states that the disease has ceased both in Mecca and Jeddah, but it is also reported that it appeared among the land caravans destined for Persia and Damascus, and its progress among the caravans and in the districts through which they pass has still to be learned. On the sea route northward from Jeddah the disease was carried by pilgrims to Tor, the quarantine station for Egypt in the Sinai peninsula. One death from cholera was reported on the voyage up to January 11, and five deaths from the disease among the 5,000 pilgrims assembled there at the latter date. These numbers must be received with considerable reserve. Egypt, however, seems as yet to be quite free from the malady. The quarantine regulations of the Egyptian Government are stated to have been enforced with unnecessary strictness, and at the expense of much suffering among the pilgrims.

Internal Fat.—The University crews have commenced practice for their annual race on the Thames, which at present is fixed for April 13, though it is just possible that it may be rowed on April 6, to suit the convenience of the Oxford men. Each year we hear of improvements in the method of training pursued, and a discarding of many absurd restrictions and antiquated ideas. There is one notion, however, that still holds firm possession of the rowing man's mind, and that is the doctrine of internal fat. The shortness of breath he experiences at the commencement of training he will admit is caused by embarrassment of the respiration and circulation before the system accommodates itself to the work thrown on it by the increased muscular exertion. But when this accommodation is effected, how is it, he argues, that he occasionally finds his wind fail him over the course, unless the view of internal fat be adopted? The supposition, however, of a deposit of fat occurring to any extent at the age at which the majority of men go into training is untenable, and the suddenness with which the respiratory trouble appears and disappears is against the time-honored view. The rational explanation of these occasional attacks of "short wind" lies in a distended condition of the bowels, either with undigested food, or flatulence, or accumulated fæces; for constipation is one of the rowing-man's chief difficulties. The dyspeptic trouble may be due to an exhausted condition of the body, and may be a sign that the muscular exertion is too severe; but generally it is due to taking a heavy meal too soon after hard exercise. The presence of undigested food, as well as accumulated fæces, leads to flatulence, by which the distended bowels become still more distended. And it is easy to understand that whatever distends the bowels encroaches upon the respiratory cavity and embarrasses the breathing. Instead, therefore, of attempting to diminish an imaginary deposit of fat by increased exertion or restriction of certain articles of diet supposed to favor its formation, he should combat "this wind in the wrong place" by a change for a day or so to a lighter and more digestible diet—from beef and mutton to poultry—and clear the intestinal canal at the earliest opportunity of the undigested residue and fæcal matter with a dose of Friedrichshall or Pullna water.

Diabetes.—The credit of first discovering the presence of sugar in diabetic urine undoubtedly belongs to Thomas Willis, the celebrated physician of the reign of Charles II., and for many years Professor of Natural Philosophy at Oxford. His discovery, however, was not due to the employment of any rigid scientific method, but by a happy chance; for observing some bees greedily hovering round a specimen of diabetic urine, he tasted it and found it sweet, "*de gustibus non est disputandum.*" But the fact that diabetic urine contained a peculiar solid residue was first noticed by Paracelsus more than a hundred years before Willis applied his rough test. In his treatise "De Morbis ex Tartaro orundis," chap. 1, book ii., published at Basle, 1527, the following passage occurs, and as it has never been noticed by any writers on the subject, we give it in full:

"Diabetica Passio est, sal siccum, resolutum et scissum, per ingressum acuti membri principalis. Hoc sal est chronicum permanens et fixum. *Signa:* Sitis cum chronico tempore, dolor spinæ (quæ plerumque in ischiâ incipit); tumores in pedibus equales; urina multa, crocea atque rubicundissima; pulsus velox, et dolores in ischia, id est coxendice. *Cura* per anodyna solum sal scissum curatur. *Descripta anodyna:* ℞ De liquoribus papaveris ʒss, lotil ʒj., camphoræ ʒj., rosanum plantaginis solatil ℈iss: reduc in formam liquidam."

The discovery and description of this residue was a great advance on the knowledge of the ancients, who held that diabetes was simply an excessive filtration of the aqueous part of the blood, caused by relaxation of the kidneys. Moreover, the passage above quoted is the earliest reference to the treatment of the disease by opium. The credit of this treatment has been variously assigned to physicians of much later date.

Death of M. Claude Bernard.—This highly distinguished French physiologist died on Sunday evening, Feb. 11th, and will be regretted by the whole scientific world. He was a member of the Academy of Sciences, Professor of Medicine in the College of France, and Professor of General Physiology to the Faculty of Sciences of Paris, and had thus attained the highest honors his country could give him. He was born in 1813, at St. Julien, near Villefranche (Rhone). His principal works, with which every one is more or less familiar, and on which his fame is founded, were: "A Memoir on a New Function of the Liver," in which it was maintained that it is a sugar-producing organ, published in 1803—"A Memoir on the Pancreas, and on the part played by the Pancreas in digesting Neutral Fats," published in 1856, both masterpieces of experimental physiology, and the foundation of all the work that has since been done in this direction. In addition to these he published almost every year one or two courses of lectures delivered before the College of France, and which abound with new and interesting facts and details of novel methods of research. Thus in 1855-56 he published his lectures on experimental physiology applied to medicine; in 1857 those on the effects of poisonous and medicinal agents; in 1858 those on the physiology and pathology of the nervous system; in 1865 those on the properties of living tissues; in 1872 those on experimental pathology and on general physiology; in 1875 those on anæsthetics and on animal heat. No inconsiderable amount of work for one man to accomplish, especially when the high quality of the work is taken into consideration. In the earlier part of his career he studied under Magendie and Flourens, then at the close of their labors; and with Matteucci and Brown-Séquard attended the lectures of Longet. As long ago as 1846 he was engaged in giving lectures and demonstrations on physiological subjects in a room near the Ecole Pratique. He was an able lecturer, illustrating his lectures by numerous experiments, and, with the means at his disposal, may be said to have possessed extreme delicacy in manipulation. It is understood that he is to have a public funeral, which will no doubt be attended by a large number both of French and foreign men of science.

Blue Bile.—An instance of a remarkable blue coloration of the bile has been lately published in *La France Médicale* by Professor Andouard. The occurrence of such a phenomenon has been asserted by physicians of old, and instances have been met with of a similar condition in animals. The example now recorded occurred in a woman, in whose vomit were observed flakes of an intense blue tint. These led to the suspicion that she had been poisoned with copper, and a judicial investigation was ordered. It was soon ascertained that the colored matter did not contain a trace of copper, and a microscopical examination did not reveal the presence of any lower organisms on which blue tint could depend. This suggested that the appearance was owing to a pathological secretion, and further investigation led to the opinion that the color depended on the bile, the pigment of which was altered. The colored spots were treated with boiling water, the fluid was filtered, concentrated, and part was treated with nitric acid. A violet tint was produced, changing to red and then to yellow, just as a solution of biliverdin. The remainder was treated with alcohol, and the solution again filtered, evaporated to dryness, and redissolved in water. Part of the resulting solution was found to give, with Pettenkofer's test, the red of biliary acids. The remainder, treated with permanganate of potash and with chloride of barium, showed the presence of sulphuric and taurocholic acids. There could thus be little doubt that the substance was bile, the tint of which had been modified by some unknown influences. Further observation showed that the blue pigment was soluble in boiling water, but only slightly soluble in alcohol, and not at all in ether, chloroform, amyl-alcohol, or benzol. Its aqueous solution was neutral, of a bright blue tint, and, when sufficiently concentrated, fluoresced in red. It was not affected by sulphuric or hydrochloric acid. Nitric acid did not affect it in the cold, but changed it, when heated, to the tint of a dead leaf. Ammonia, potash, and soda changed the tint to a pale yellow. The spectroscope showed a relation between the substance and the oxidation products of bilirubin and biliverdin which were obtained by Jaffi and Stokyis, and designated choleverdin and cholecyanin. The other reactions showed an affinity to the black pigment obtained by Ritter from human bile, and found also in the bile of the ox, sheep, pig, dog and cat.

The London Small-Pox Epidemic.—The fatality of small-pox continues to increase in London, 55 fatal cases having been registered during the week ending Feb. 9. The nineteen other large English towns dealt with in the Registrar-General's Weekly Return enjoy a remarkable immunity from the disease. During the three weeks ending Feb. 9th, 129 deaths from small-pox were registered in London, whereas not a single death from this cause was recorded in the nineteen other towns, having an aggregate population slightly larger than that of London.

The Metropolitan Asylum Hospitals contained 536 small-pox patients on Saturday last, against numbers increasing steadily from 137 to 542 between the beginning of October last and the 2d inst. The number of new cases admitted to these hospitals during last week was 127, against 126 and 146 in the two preceding weeks. The number of patients in the Highgate Small-Pox Hospital has, moreover, steadily increased from 26 to 57 during the past seven weeks. In the outer ring of metropolitan suburban districts 6 deaths from small-pox were registered last week, of which 3 occurred in West Ham, 1 in Kingston, 1 in Chislehurst, and 1 in Acton registration sub-districts.

A Fatal Laundry.—An illustration of the dangerous *rôle* in propagating disease which the laundry occasionally plays was given at a recent meeting of St. Olave's Board of Works. The medical officer of health reported that a serious outbreak of typhus fever had occurred at a certain yard, necessitating the removal of five persons to the hospital. On making inquiries, it was found that a young woman who lived with her mother and brother at one of the houses brought home from "the other side of the water" some clothes to be washed, which had been worn by a patient suffering from typhus fever. The consequences were immediate and tragic. The two women, the man, and two neighbors were attacked, and four out of this number died in hospital. The house was at once closed, and most of its contents burnt, while the Board very rightly directed the medical officer to make further investigation into the circumstances of the fatal importation. We trust the inquiry will be thorough and complete, and will result in the detection of the culpable parties. A published account of the whole affair will, after a time, be desirable.

Disinfecting in Dublin.—The sanitary authorities of the city of Dublin have been busy since the commencement of this year. The death rate of the past four months amounted to 27·4; the registered deaths were 734, against 763, the ten years' average of the corresponding period. This is a decided improvement, and becomes the more encouraging when we are further informed that the deaths attributed to zymotic diseases amounted to only 107, while the average has been 151. Thus the fatal consequences of preventable diseases have been reduced to the extent of about one-third. This result is explained by the fact that, according to the report of the superintendent medical officer, "the humble people go readily to the hospital, their clothes and bedding are disinfected or burnt if of small value, and the rooms are fumigated. From the weekly returns it appeared that 22 infected dwellings were disinfected, and 131 articles had been sent to the disinfecting chamber. Notwithstanding all these precautions, small-pox is still prevalent to an alarming extent; but this is only natural when we consider the overcrowding and poverty which, combined with dirt and slovenly habits, are more especially characteristic of the poorer quarters of Dublin than of the large towns on this side of St. George's Channel.—*Lancet.*

THE HOT WATER TREATMENT.

Service of Dr. Frank H. Hamilton, Bellevue Hospital.

December 18, 1877, John Meagher, aged about 25 years, a switchman on the Long Island Railroad, was run over by two platform cars. During three days he remained under the care of a physician at Hunter's Point, refusing to submit to amputation.

December 21, he was admitted to my wards, Bellevue Hospital. My House-Surgeon, Dr. W. S. Halsted, who examined him at once, and who was throughout in immediate charge of him, reported to me that he was, on admission, pale, and a little bronzed—his breath had a slight saccharine odor, the surface of his body was cold, his pulse weak, thready and rapid. He was delirious, talking in a low voice and incoherently.

The right thigh had suffered a severe laceration just above the knee, the wound being about ten inches long, and closed by sutures. It was emitting a strong gangrenous odor. On removing the sutures, the underlying structures were found extensively contused, the bone bare, and the wound filled with masses of undetached gangrenous tissue.

His left thigh was broken about three inches above the knee-joint, the upper fragment penetrating the joint. The whole limb was cold, swollen, discolored, emphysematous, and pulseless.

His condition did not warrant an amputation. In this opinion Dr. Wood and the House Staff concurred. A long splint was laid beside the broken limb and secured by bandages, heat applied to the extremities, a weak solution of carbolic acid was employed to correct the fetor, and nourishment with stimulants were administered. Speedy death was anticipated.

On the following day his mind was more clear, but he was still very feeble, and the gangrene was extending in both limbs. Amputation was advised, but the parents refused their consent.

December 23.—Gangrene still extending, in the left leg involving the whole limb as high as the knee, and a discoloration existing as high as the groin.

The entire left leg and thigh were now enveloped in cotton batting, saturated with hot water—water at about the temperature of one hundred and ten degrees of Fahrenheit—and the laceration on the right thigh was treated in the same manner. Outside of the cotton batting each limb was inclosed in oiled silk, and the patient was made to repose on a sheet of oil-cloth.

From this time, December 23, to when the left leg was removed at the knee-joint, the hot water was renewed every twenty or thirty minutes, day and night.

December 25, the discoloration, suspected to indicate approaching gangrene, has nearly disappeared from the left thigh, above the fracture. A line of demarkation is forming at the knee-joint. Delirium abating. He begins to take food. Rests well.

December 29, no delirium. Says he feels well.

January 6, 1878, nineteen days after the receipt of the injury, and thirteen days after the commencement of the hot water treatment, the separation at the left knee joint was so nearly completed that with my scissors I cut the remaining sloughy bands, and removed the leg, without inflicting pain or causing the loss of only a few drops of blood.

The gangrenous slough had already separated from the opposite thigh.

January 7, removed to a water bed, being threatened with a bed sore.

January 15, right knee painful and swollen, but on the following day a profuse discharge occurred from the wound above the knee—probably from the joint—and the patient was relieved.

January 22 to 31, three or four small abscesses appeared on right limb and were opened.

February 8, last report, patient gaining in strength; wounds healing on right limb. Lower fragment of femur (left limb) projecting, and the necrosed extremity of bone gradually separating from the shaft. The lower fragment, about four inches, including the joint surface, dead, but still hanging by two bands of living soft tissue. Granulations healthy and cicatrization progressing; water dressings discontinued when the leg separated; balsam of Peru being substituted. His final and complete recovery is now assured. Possibly after a time resection of the bone may be required to make a good stump, but probably not. The lower fragment might be removed at any time with the loss of a little blood, but it has been deemed advisable to wait until the patient's strength is better established.

This is not the first time that I have obtained a similar result from this plan of treatment, and while I am not prepared to say that it will always prove successful in arresting traumatic gangrene, and in securing a prompt separation of the dead parts, it is proper to say that the method always deserves a trial when amputation cannot safely be practiced.

It is worthy of remark that from the second or third day after the commencement of the hot water applications there was almost no apparent constitutional disturbance. The patient took no medicines.—*Hospital Gazette.*

THE "LORD OF SNAKES."

Dr. John Shortt retires from the Medical Service at the end of this month [January], and Madras will lose in him one who has quite a European reputation for his knowledge, especially of snakes and snake-poisons. For a great number of years his wide knowledge and curious researches in natural history have been at the service of the public, and he has made himself a name, the honored memory of which will not soon pass away. His experiments, taking the novel range that they have, have not always proved successful, and he has often laid himself open to a hearty laugh. But his experiments were always made in useful directions, and his failures resulted not from zeal or lack of knowledge, but from the very nature of the difficult subjects he boldly and laboriously attempted to grapple with. What laughter there was was always kindly, and every one worthy of respect in our midst always respected the enthusiastic old man whose name is a household word among us. We trust that in his retirement the Madras public will do some act of marked recognition of his long services, which have been, in the best and truest sense, *popular.* He worked for the *people.* The people should remember this. There are more interesting, characteristic, amusing, and instructive stories about him than about any other man in this Presi-

dency; and if he does not write an autobiography at which every publisher in Madras would only be too happy to make a foremost rush, some history of his life should be written by a friendly and practiced hand. Here is a hint for Messrs. Higginbotham & Co., Messrs. Gantz, and the rest of our book-making and book-vending world! But a note should be taken of this. Over and above the mere details of Dr. Shortt's life and career, the book which should be compiled should contain, above all, the pick of the best anecdotes current concerning him, and the practical beneficial results of his many-phased work in this Presidency. He who desires a laugh should have room to indulge in a harmless, genial one, at what in his own complacency he may deem eccentricity on the Doctor's part; and he who desires the sounder food of meditation over a long, an honest, and an honorable career of usefulness, should have that given him in abundance. Were some of our publishers to get a competent literary man in Madras to undertake the task of Dr. Shortt's biography, the venture would be worth the intelligent support of Government, for Dr. Shortt's career has been of a kind which is just of a nature that history generally takes notice of. There have been many more brilliant and learned men in the Indian medical profession than Dr. Shortt, but he has worked in a world of his own, his bent of mind has carried him to many places where there lay no foot-print of other investigator before him. And he has done that which we all should strive to do—he has opened, to the best of his power, the bounds of knowledge to the commonest intellects around him, and made even the meanest feel interest in the cunning handiwork and wise secrets of that good Master Mason—Nature. Hindoos worship the snake—many of them almost go the length of doing divine honor to him who is the "Lord of Snakes!" If we were to try to tell only one quarter of the best-known stories of Dr. Shortt and his snakes, we should run out our article to an unconscionable length. Many of these tales have lost nothing by being told by natives, and are long, mysterious, and savoring of the age of the serpent-tressed Furies. Strange, is it not, that these Furies used to be reverently called the *Eumenides* by the ancient Romans, just as the Tamils propitiate the venomous cobra by the name *Nalla Pambu*—the *Good* Snake! In many a little hamlet of this Presidency even children who have never seen a European face have heard of the "Great Madras Snake Doctor." Had Dr. Shortt only lived a century or so ago, some curious archæologist would, doubtless, have seen rude idols of him in the niches of many a way-side temple, seated crossed-legged, blandly playing with a boa-constrictor coiled round his waist, and having the extended hood of a cobra overshadowing him in umbrella-fashion! *Sta'a Puranas* might have been in his memory, who first taught the use of the fire-water of the white-faces as an empyric remedy against snake-poison.

This story, if not true, is a good one: One day a poor fellow staggered into Dr. Shortt's veranda, and faintly told the Doctor that he had been bitten by a cobra. Just then the Doctor had run short of ammonia. Recourse was had to brandy. The patient managed to imbibe half a bottle of the medicine; a pleasing expression, as of relief from pain, gradually overspread his countenance. A gentle and soothing sleep now overtook the sufferer. The slumber was long and profound. When the patient awoke, the doctor was delighted to find that all traces of blood-poisoning had vanished. The late sufferer only had a bad headache, felt very thirsty, and wanted some more of the medicine. Dr. Shortt was enraptured with his success, but his feelings were somewhat ruffled when he afterward found that same man coming back to him every two or three days subsequently, declaring that a cobra had bitten him again, and—he wanted a little "more of that nice medicine!" At last a new remedy had to be tried; it was a remarkably short, terribly sharp, and decisively curative exterior application! Sudden life revivified the comatose patient. Giving vent to a wild yell of surprise, he bounded away with a nimbleness only generally observable in alarmed antelopes and frightened fleas. The new cure was not only a temporary one. He never came for treatment again. Even cobras seemed to avoid him henceforth in a remarkable manner! Dr. Shortt was so pleased with his success, that he fondled his dear little pet drawing-room snakes more affectionately than ever.

Those pets, those slimy, sleek pets!—who has not heard of them? who has not heard of their playful little wriggles; their gentle, low, alluring hisses; their pretty, pearl white, gleaming teeth; their long slim tongues, which they so delight to pop out of their mouths, at unexpected moments, in a grotesque manner; their sudden frolicsome jumps at the legs of strangers they wish to become intimate with; the gray-green glimmer of their scales; and the dreamy, fascinating look in their glamorous, grave eyes—black as thunder-clouds, till they brighten up with some mysterious, vivid rapture—who has known Madras, and not heard of all this? —of how they coil gracefully round the legs of chairs to enjoy a *siesta* on the cushioned seat; how they love the seclusion of the Doctor's pockets, if they can't slyly get into one of those of his visitors; of how it is desirable to give them every morning a bit of India rubber to bite—to draw off the poison from their fangs, or rather "clean their pretty little teeth for them, you know!" as the Doctor tenderly will say; how, being boxed up for the night, they won't go at once to sleep, the silly dears, but will frequently quarrel, as naughty children do, bless their little hearts; how they entertain the poetical idea that the dresses of ladies are patches of verdant flowery meadows, intended for them to disport themselves upon; and how they evidently think that their Doctor-friend is only a great King Snake after all, whom they mustn't bite—only try to do so, now and then—only in fun!

Then, have our readers heard of the hawk which Dr. Shortt's bull-headed viper fascinated when it was swooping down on one of the Doctor's chickens? Have they heard of the story of the two cobras, the monkey, and the meat-mincing machine? Have they heard of the hungry carpet-snake which ate three-quarters of itself? Of the big-mouthed frog and the three green snakes? Of the friendly mongoose, and of the pet rattlesnake which mistook it for a rat? The voracious rock-snake that swallowed a bottle of the Doctor's prussic acid, which did it no harm till it tried to coil itself round a pillar, and the bottle broke inside it? Of the pepper box and the sneezing tree-snake? Of the snake which wagged its tail; of the sleepy snake; of the twin boa-constrictors which tried to swallow each other; and of "Teetotaler," the Doctor's pet water snake, which, when it died serenely in its own unintoxicating element, he cruelly preserved in strongest spirits of wine? Have our readers not heard of all this, and a thousandfold more? Let us hope, then, that the biography we have spoken of will soon be published!

It is curious to note how one-sided Dr. Shortt's reputation is, as far as the general public is concerned; yet it is just these one-sided reputations which often make the most mark. Dr. Shortt excels in many things; his botanical knowledge is, for instance, considerable; but it is as a "Snake Doctor" that he is mainly famous. It were as easy for most Madrassees to imagine India to be without snakes as to imagine the Dr. Shortt of our Presidency as one who had never pickled a cobra or carried about a little bottle of ammonia in his waistcoat pocket! Seriously speaking, the fact is simply incontestable that, in his knowledge of snakes and their poisons, Dr. Shortt not only stands now alone in India, but there probably never was in India a man who knew so much about those particular subjects. Dr. Shortt's knowledge of serpents rivals our Duke's knowledge of able men, Sir Richard Temple's knowledge of hard-riding and voluminous report-making, and Lord Lytton's knowledge of pretty phrases and prettier faces. On his own peculiar eminence our worthy Madras Doctor stands as supremely alone as ever Saint Simon Stylites did. Every native snake-charmer looks up to him as a newly initiated Mason looks up to the Master of his Lodge. And the heart of many a gallant officer is said to have perceptibly heaved a trifle more rapidly under the medals on his breast when the Doctor was met and conversed with, and strange audible hisses were heard to issue from the medical man's mysteriously agitated coat pockets. To the imaginative Oriental the presence of Dr. Shortt has sometimes—so the story goes—proved too weirdly impressive; and cases are hinted at when hartshorn has had to be employed as a revivifying agency when the patient, whose pulse was being felt, has too unexpectedly observed a little gray-eyed, green-chinned, glittering snakeling curled round the Doctor's wrist. But these are merely idle tales—though, unfortunately, there are so many of them. Dr. Shortt himself is only very partially acquainted with the fame he enjoys. Does he know—we doubt it—of the Tamil doggerel bazaar rhymes about him, commencing—

Pambu natan Daktar Shartter.
Sambal pûsi vananguvên! &c.—

the first few lines of which spirited production may be thus translated:

Before the Lord of Serpents,
With ashes on my brow,
Before him, Shortt, the Doctor,
Full reverently I bow!

I bow, and offer to him
The flowers that most may please,—
Chamback—yellow mohurs,
And jasmine—white rupees!

After some stanzas, the poet proceeds to state several of the specific reasons for his worshiping Doctor Shortt. Here are two of these reasons:

At morn my son was playing
Nigh to my garden wall;
I saw the gray snake strike him,
I heard his piteous call.

Amongst the flowers at evening
My daughter sat and sang,
Nor ceased her joyous carol
Till a fell viper sprang!

Heart-rent, from forth my gateway
I stept and sobbed aloud,
When straight the Lord of Serpents
Came through the assembled crowd.

He gave my children caustic,
Ammonia—nectar gave—
Triumphant over Poison,
Victorious o'er the grave!

If he has not already done so, Dr. Shortt should possess himself of this interesting Madras native lyric. But we must leave now for a while Dr. Shortt and these specimens of verses in honor of him. When the autobiography or biography we have referred to appears, we have no doubt but that we shall be able to praise and the public to appreciate it. "Men whom Indian has known" should not always be left unwritten of till they are past and gone. Let the photograph be taken from the living not the dead face. Especially true of India is it that—in the case of the deeds of men as well as the produce of trees—there should be no delay in the gathering of good fruit as soon as it is ripe and ready for the gardener's hand.—*Madras Times.*

ACTION OF THE COPPER-ZINC COUPLE ON ALKALINE OXY-SALTS.

By DR. GLADSTONE and MR. TRIBE.

IN 1873 Prof. Thorpe proved that the couple converts all the nitrogen of niter in the presence of water into ammonia. The authors had previously observed that nitrites were first formed, and have now made an exhaustive study of the reaction. This chemical change starts somewhat energetically, then diminishes considerably, again increases, and finally ends more rapidly than it began. Ammonia and its equivalent of potash slowly increase from the commencement until the time when the maximum amount of nitrite is produced, when this salt rapidly breaks down, and is of course accompanied by an increasing amount of the alkalies. Solutions of ammonia containing 0·026 and 0·256 per cent increase the action of the couple, but stronger solutions diminish it. Solutions of potash from 0·08 to 60 per cent. increase the change. By pouring a 10 per cent. solution of niter with enough copper sulphate to color the liquid distinctly on to some granulated zinc in a tap funnel, and allowing it to remain a few seconds, enough nitrite is formed to give the characteristic green color of copper nitrite, and to give a blue coloration with starch, potassium iodide, and acetic acid. The latter reaction can be used as a delicate test for nitrates—5 c.c. of solution, 12 drops of copper sulphate, and 4 to 5 pieces of zinc foil, 1 by ½ inch; allow to stand for three minutes, then pour into 5 c.c. of the starch solution containing potassium iodide and acetic acid. On the whole the authors think that the following is the most probable explanation: that the two metals electrolyze the niter with the formation of nitrate of zinc, the reduction being effected at the negative pole through the agency of the potassium. Many experiments were made, but without absolutely settling the question. By electrolyzing potassium nitrate solution in a V-shaped tube zinc nitrate was formed in the zinc limb, and potassium hydrate with smaller quantities of potassium nitrite and ammonia in the copper limb. The copper-zinc couple converts potassium chlorate readily into potassium chloride. No chlorites or hypochlorites were formed. By electrolyzing the greater part of the hydrogen escapes as gas instead of the potassium chlorate being converted into chloride, the reason being that with the couple the hydrogen is probably wholly occluded the moment it is set free; in electrolysis only a small quantity of the gas is condensed by the negative plate. The authors consider the following statements proved:—1. The action of the copper-zinc couple on these oxy-salts is of an electrolytic nature. 2. The negative radical combines with the zinc, while the positive radical or its equivalent of hydrogen from decomposed water is set free against the copper crystals. 3. The reduction and hydrogenization of the salt take place in the immediate vicinity of the negative metal; also, it is probable that hydrogen is actually set free against the copper, but is condensed by the finely-divided metal, and in that condition does its work of reduction and hydrogenization. The action of the couple on ammonium nitrate was found to be substantially the same. If the reaction be attempted at or near the boiling-point the nitrite formed is decomposed, nitric oxide being evolved.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

ORDINARY meeting, January, 8, 1878. E. W. BINNEY, F. R.S., F.G.S., President, in the Chair.

Meteor.—The President said that on the 31st of December last, at about 5.30 p. m., he was walking from Ainsworth to Bury, and he observed a large meteor which started from the star Pollux, and after making a slight curve upward disappeared near the star Beta in Taurus. It seemed larger than the planet Venus, then brightly shining, and was of a yellowish white color, and disappeared without breaking. It left a luminous track of its entire course for a short time after it had passed.

"*Note on the Decomposition of Water by Iron Pyrites*," by C. A. BURGHARDT, Ph. D. I have recently endeavored to ascertain what part iron pyrites plays in the formation of the natural sulphides of other metals, such as copper glance, copper pyrites, etc. These and other sulphides are supposed to arise through the reduction of the corresponding *sulphates* of those metals by organic matter. Bischoff, in his "Chemical and Physical Geology," vol. iii., p. 554, says: "The production of sulphides presupposes the existence of sulphates; and the elimination of sulphur from sulphates, either in combination with hydrogen, or with the metals of the alkalies, or alkaline earths, presupposes the existence of organic life, since that effect would be produced only by carbonaceous substances. The influence of organic substances in the production of sulphides is further shown by the fossil remains, consisting of iron pyrites, blende, copper pyrites, variegated copper pyrites, sulphide of copper, and cinnabar." This theory appeared to me to be open to serious objections, as it would be very difficult to show the presence of organic matter in many crystalline rocks sufficient to produce the large sulphide formations often occurring in them through the reduction of sulphates. I therefore desired to ascertain whether sulphureted hydrogen could be produced by simpler means, and in accordance with the occurrence of sulphides in rocks *free from organic matter*. With this view I placed some pure finely-powdered iron pyrites into a glass tube, covered it with perfectly pure distilled water (previously well boiled in order to drive out any air dissolved in it), placed the tube and its contents in a vessel containing boiling water, heated it gently for a short time to drive out any air which might have been contained in the tube, and sealed the latter up. After heating the above in an air-bath for four days, at a temperature of about 120° C., the tube was opened, when a very strong smell of sulphureted hydrogen was instantly perceived, and proved to be present by its chemical reactions. The liquid contents of the tube were analyzed, and found to consist of ferric sulphate, ferrous sulphate, and free sulphuric acid, while there was a slight deposit of ferric oxide upon the sides of the glass tube. This experiment certainly proves that sulphureted hydrogen can be produced in the interior of the earth *without* the presence of organic matter, as all rocks (both crystalline and sedimentary) contain more or less iron pyrites disseminated throughout them, and are also saturated with water. I hope soon to determine quantitatively the reaction which occurs in the above experiment.—*Chemical News.*

NEW METHOD FOR THE DETERMINATION OF BOILING-POINTS.

By H. C. JONES.

A PIECE of glass tube, 4 m.m. internal diameter and 200 m.m. long, is bent in a U, so that the end which is open extends at least 15 m.m. beyond the other, which is closed. The bend is made in the form of a circle about 20 m.m. in diameter. The liquid, two or three drops of which will be quite enough for the determination, is introduced into the closed end of the U-tube; the open end is placed underneath the surface of some mercury contained in a small porcelain crucible. The whole is then slung by means of copper wire into a water or paraffine bath, and the temperature of the latter gradually raised. The liquid will of course boil and the vapor drive before it the air. On cooling, the whole tube, which the author calls a tension-tube, is filled with mercury, a bubble of liquid occupying the top of the bend. The tube is then inverted and the liquid transferred to the closed end of the tube. Any water or paraffine is now removed from the tube, and some mercury emptied from the open limb. The method of determining the boiling point is as follows:—The tube is immersed in a paraffine bath, care being taken that the pen end is freely exposed to the air. The temperature is then gradually raised, and as the temperature approaches the boiling-point of the substance, the mercury falls in the closed limb, the tube being gently tapped. At the moment the mercury levels in the two limbs are equal the temperature of the bath is taken by a delicate thermometer placed close to the liquid in the closed limb. The bath is allowed to cool, and the temperature at which the levels pass each other again noted; and so six observations are made, the mean of which gives the uncorrected boiling-point. Many determinations are given in the paper, which agree well with each other. The advantages of the method are obvious, the small quantity of the substance required being one of the most important. Moreover, the tension-tube can be labeled and put away for future verification. By using a spermaceti bath boiling-points up to 300° C. can be determined.

XYLOPHILIN.—This substance, the cause of the violet shade which certain vegetable membranes display on contact with hydrochloric acid, is a colorless substance, soluble in water and alcohol, found in more than 60 per cent. of woody plants and 30 per cent. of herbaceous plants.

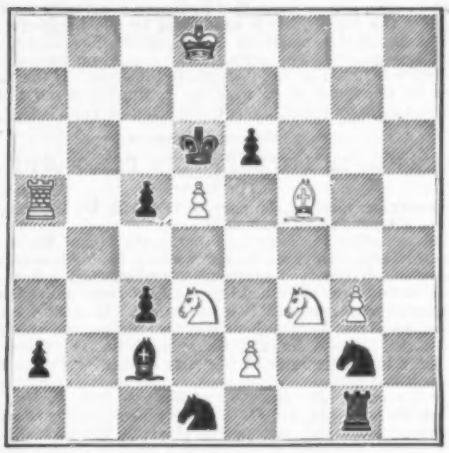
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N J.]

PROBLEM No. 66. BY A. BAYERSDORFER.

First Prize in the West German Chess Association of 1876.

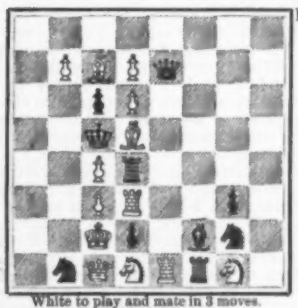
Black.



White.

White to play and mate in four moves.

FRANÇOIS ANDRE DANICAN PHILIDOR.



White to play and mate in 3 moves.
By DR. C. C. MOORE.

LITTLE as is known of the actual strength or style of this famous player, owing to the remote date as well as limited number of his games, his fame has become a matter of history, and to no other player has such an undisputed title of chess champion of the world been accorded.

The records of his victories, as well as the minutest details of a long and varied life, have been faithfully preserved.

We find that in the early part of the seventeenth century an Italian hautboy player of the name of Filidori visited France, and produced such a strong impression upon Louis XIII. by his brilliant performance that, when a young French musician of the name of Danican appeared in Paris, his skill was so marvelous that the King exclaimed, "I have recovered my Philidodri; I have found a second Philidor," which title of *Philidor*, so brilliantly won, was adopted by Michael Danican and his numerous descendants. His children became famous musicians and were attached to the court or royal chapel. François André Danican Philidor the youngest of eight children, was born Sept. 7, 1726, and at the age of fourteen became a professional musician, at which time he had also acquired the reputation of being a most skillful chess player, and "the best Polish draught player who had ever lived." At the age of eighteen he was engaged to give concerts throughout the Continent, but, owing to the failure of the enterprise, it resulted in a prolonged chess tour, and from this time forward we find that he contested games or played matches with the leading players of Europe, returning to Paris after an absence of nine years.

The London Chess Club entered into an engagement to pay him a liberal income to spend a few months of each year in London. Either for this or for reason of political views that forbade his return to France, he spent the remainder of his days in England, devoting his time to the composition of music and playing chess.

He died in the year 1795, having been for upward of half a century the acknowledged chess champion of the world, unquestionably never having met his equal at our royal game.

The portrait we obtained, during a visit to Paris, from an old engraving in the possession of a grandson of the famous master. We were pleased to learn that chess has always been cultivated in the family, and that there was no foundation for the popular story that Philidor forbade his children to learn the game.

As a specimen of his play, we select one of his blindfold games, for which he was so famous.

PHILIDOR'S BLINDFOLD GAMES.

One of three games played simultaneously by Philidor at the London Chess Club, May 8, 1783.

COUNT BRUHL.	PHILIDOR.
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. B to Q B 4	2. P to Q B 3
3. Q to K 2	3. P to Q 3
4. P to Q B 3	4. P to K B 4
5. P to Q 3	5. Kt to K B 3
6. P x P	6. B x P
7. P to Q 4	7. P to K 5
8. B to K Kt 5	8. P to Q 4
9. B to Q Kt 3	9. B to Q 3
10. Kt to Q 2	10. Q Kt to Q 2
11. P to K R 3	11. P to K R 3
12. B to K 3	12. Q to K 2
13. P to K B 4	13. P to K R 4
14. P to Q B 4	14. P to Q R 3
15. P x Q P	15. P x P
16. Q to B 2	16. Castles K R
17. Kt to K 2	17. P to Q Kt 4
18. Castles K R	18. Kt to Q Kt 3
19. Kt to K Kt 3	19. P to K Kt 3
20. Q R to B sq	20. Kt to Q B 5
21. Kt x B	21. P x Kt
22. Q to Kt 3 ch	22. Q to Kt 2
23. Q x Q	23. K x Q
24. B x Kt	24. Kt P x B
25. P to K Kt 3	25. Q R to Kt sq
26. P to Q Kt 3	26. B to R 6
27. R to Q B 2	27. P x P
28. P x P	28. K R to Q B sq
29. R x R	29. R x R
30. R to R sq	30. B to Kt 5
31. R x P	31. R to B 6
32. K to B 2	32. R to Q 6
33. R to R 3	33. B x Kt
34. R x B	34. R x Q Kt P
35. R to B 3	35. P to R 5
36. R to Kt 7 ch	36. K to Kt 3
37. P x P	37. Kt to R 4
38. R to Q 7	38. Kt x P
39. B x Kt	39. R to B 6 ch
40. K to Kt 2	40. R x B
41. R x P	41. R to B 6
42. R to Q 8	42. R to Q 6
43. P to Q 5	43. P to B 5
44. P to Q 6	44. R to Q 7 ch
45. K to B sq	45. K to B 2
46. P to R 5	46. P to K 6
47. P to R 6	47. P to B 6

And white resigned the game.

FRANÇOIS ANDRE DANICAN PHILIDOR.

THE latest advice from England reports the match between Miss Rudge and Mr. Thorold as being nine to nine; we give the following on account of its pretty termination:

CENTER GAMBIT.

Remove White's Q Kt from the board.

MR. THOROLD.	MISS RUDGE.
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. P to Q 4	2. P takes P
3. Kt to K B 3	3. B to B 4
4. B to Q B 4	4. P to Q 3
5. P to B 3	5. P takes P
6. Q to Kt 3	6. Q to B 3
7. B to K Kt 5	7. Q to Kt 3
8. Castles (Q R)	8. P takes P (ch)
9. K takes P	9. Kt to Q B 3
10. P to K 5	10. B to K 3
11. P takes P	11. B takes B
12. Q takes Kt P	12. R to Kt sq

White mates in three moves.

CHESS IN NEW YORK.

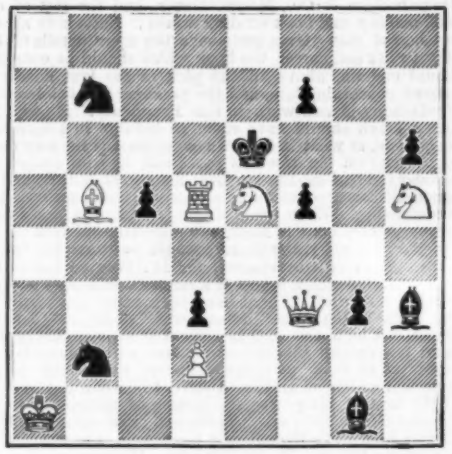
OWING to pecuniary complications the *Café International*—which has of late years become so closely associated with American chess—was compelled to close its doors, and the chess frequenters are endeavoring to find a suitable locality for the formation of a new chess café. The Café Logeling, on the Bowery, is becoming headquarters for our players, and has accommodations for any number of players. Commodious rooms have been secured there by the Manhattan Chess Club, which is already a most flourishing association.

We have been in receipt of innumerable letters, many of which are anonymous, and others in which the writers have neglected to give their address, in both cases rendering it impossible for us to reply to the communications, some of which were quite important. Being desirous of forming a private chess directory for the distribution of such information as we often find inconvenient to introduce in our department, also for the purpose of ascertaining the amount of interest taken in the game, we are desirous of collecting the names and addresses of such of our readers as take the paper for the sake of the chess department.

PROBLEM No. 67. BY J. BERGER.

Second Prize in the West German Chess Association of 1876.

Black.



White.

White to play and mate in four moves.

SOLUTIONS TO PROBLEMS.

No. 60.—BY HERR SCHRUEFER.

WHITE.	BLACK.
1. B to Q R sq	1. Any move
2. Mates accordingly.	

No. 61.—BY HERR SCHRUEFER.

WHITE.	BLACK.
1. Q to K Kt 5	1. Kt x Q
2. K to B 7	2. Any move
3. Mates accordingly.	
	1. K x Kt
2. Q to Q 8 ch	2. Kt x Q
3. B to Kt 6 mate.	

LETTER "A."—BY E. B. COOK.

WHITE.	BLACK.
1. Q to Q R 4	1. K to Q 4
2. R to Q 3 mate.	

JULES GREVEY, the successor to M. Thiers, has a great reputation as a chess player, and in this game and in pistol practice finds his greatest recreation.

WE are in receipt of the award of the Huddersfield College Magazine Problem Tourney, and will shortly give selections of the problems and the names of the winners. Owing to the flattering success of their first essay, the enterprising managers have already inaugurated a second tourney, toward which object Mr. Medly has added £5 from the Lowenthal fund, which will be offered as a special prize in the shape of a silver cup. The following is the programme, to which we call the attention of our problemists:

HUDDERSFIELD COLLEGE MAGAZINE TOURNEY.

No. II.

CONDITIONS.

1. The competition to be open to all the world.
2. Each competitor to contribute three original problems in from two to four moves.
3. A copy of the problems, on diagrams, with accompanying solutions, also name and address of competitor, to be sent to John Watkinson, Fairfield, Huddersfield, on or before September 1st, 1878, from composers resident in the United Kingdom, and on or before December 1st, 1878, from composers resident abroad.
4. One set of problems to be published anonymously every month in the *H. C. M.* until the completion of the series, beginning with the number for October, 1878; the award to be given on the expiration of two months after the publication of the last set.

PRIZES.

First Prize for the best set of problems.
Second Prize.
Third Prize.
Special Prize for the best four-move problem in all the sets.
Special Prize for the best three-move problem.
Special Prize for the best two-move problem.

Mr. Andrews, who has again very kindly consented to adjudicate the prizes, has drawn up the following code for the guidance of competitors.

PROPOSED PROBLEM CODE FOR *H. C. M.* SECOND TOURNEY.

Competing Problems will be Judged by the Following Scale:

	Maximum.
Beauty of Idea and Meritorious Arrangement	15 points.
Difficulty	15 "
Novelty of Idea or Arrangement	10 "
Accuracy of Construction	10 "
Variety	5 "
Economy of Force	5 "
Total	60 "

AT the coronation of Richard I. (in 1189) six Earls and Barons carried a chess board, with the royal insignia, to represent the Court of Exchequer, instituted by William the Conqueror in 1079.

VOLTAIRE was passionately fond of chess, and termed it "the one of all games which does most honor to the human mind." He played a game by correspondence with Frederick the Great of Prussia, and used to keep in his house a Jesuit priest, named Father Adam, solely to play chess with, yet by all accounts he was a very poor player.